POWER PLANT ENGINEERING

GENERATION - TRANSMISSION - DISTRIBUTION - UTILIZATION

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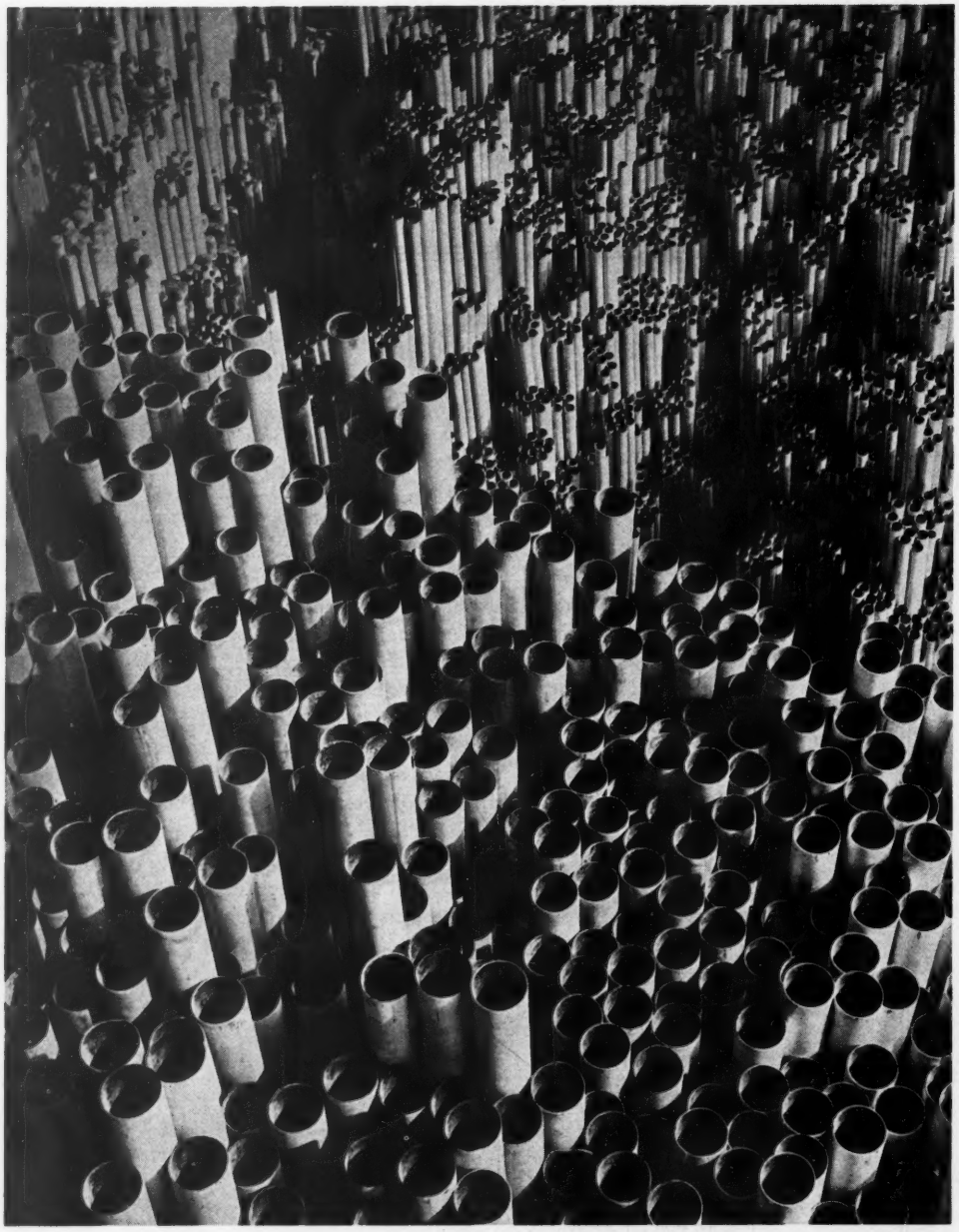


Photo. Bureau of Reclamation

PIPE DESIGN

PIPE—Steel pipe—2300 miles of it, is going into the construction of Grand Coulee Dam, being built by the Bureau of Reclamation on the Columbia River in eastern Washington. The pipe is imbedded in the concrete and cold water circulated through it to remove the heat generated while curing. This prevents cracking through changes in volume such as would occur over a long period of years if the concrete were allowed to heat and cool naturally. This is only one of many other interesting aspects of these large Federal power projects. The engineering skill involved in the construction of these great projects is truly amazing and when completed, in addition to fulfilling their useful purposes, they will stand as monuments to the genius and ability of the American engineer. • Views of other government projects will be found on pp. 648 and 649.

WITH THE EDITORS

Yardstick or Big Stick?

OPINIONS of the boosters for government and municipal encroachment into the field of power generation and supply seem to differ as to the object of such activity.

Some proponents of TVA and similar developments claim that their urge is to establish a standard of cost or "yardstick" with which the operation of privately-owned plants should be compared. The standards so far produced, when analyzed as to items included in cost of producing power, seem to resemble a steel rule of German manufacture, recently purchased by the writer, which showed up over ½ in. short in 2 ft. as compared to a standard American-made rule. The reduction of power cost by omitting interest depreciation and taxes as well as charging a considerable part of the cost of the power development to other than power production, even though there is no demand for "navigation" improvement, seems to give the power "yardstick" a length of even less than 35¼ in. But the rates charged for current delivered from the government plants seem to be based on an even shorter yardstick than indicated by the costs as given by government authorities.

Other proponents of governmental aggression advocate municipal and federal plants as a "threat" against privately owned plants to force reduction of rates, the threat being enforced by again disregarding costs, and making up deficits from taxes. This is the kind of competition planned to drive competitors to the wall, which was largely responsible for the necessity of anti-trust legislation.

Electric current for light and power is a convenience but not a necessity. Gas, gasoline, kerosene are all readily available as sources of either power or light. That private utilities must have public permission in order to distribute their product under or over the streets and highways involves an obligation to furnish service at reasonable cost. But their overhead and operating expenses must be paid for and included in the cost of the service. If that cost is more than a possible user of current can or is willing to pay, he has other methods of lighting, and of operating machinery that are available. The recent statement of a high government official that, "One of the major problems of statesmanship is to see that cheap power is provided to citizens at prices within the means of people to buy," no attention to be paid, apparently, to the real cost of furnishing that power, seems to sound like the theory that the price of a luxurious automobile must be reduced by government action so that it will be within the means of everybody, even though smaller cars are available that will go as far and as fast as the bigger one.

Establishing government as a competitor of private business in supplying power, light or transportation would seem to be justified only by public need or public demand. Since other means than electric current are to be had readily, urgent public need is not apparent.

Also current is available in practically all urban and well populated districts from private or municipal systems, and can be generated by individual installations by automatic combustion engine units at a cost but little if any greater than that for current from central systems.

As to public demand, a recent survey by the Transportation Conference showed 633 out of 666 organizations as opposed to government ownership and operation of railroads, and many of the replies specified opposition to government ownership and operation of other utilities as well. This survey was specific as to railroads, but the tenor of the replies would indicate that, had it included power generating and supply systems, the result would have been similar. The most that the public wants, in either case, is such regulation and supervision as will ensure service at the lowest reasonable cost.

Spending the taxpayer's money to create a yardstick of uncertain value or a big stick of doubtful cost does not seem to be an essential function of government. But it would seem the advocates of government ownership, by both direct pressure and flank attack, are seeking to hamstring the utilities that supply what are popularly spoken of as essential services, so that government may take over plants, equipment and operation. There would seem every probability that once these immediate objectives are gained, food and clothing stores, the building of homes and the manufacture of automobiles will be considered as "utilities supplying essentials" and will become a next object of attack. The Post Office Department is a good indication of the kind of deficits which may be expected if government takes over the operation of "utilities." Does such an outcome justify the expenditure of vast sums to create yardsticks or big sticks in order to force the owners of industries serving the public into such a position that government ownership and operation of such industries will inevitably come about?

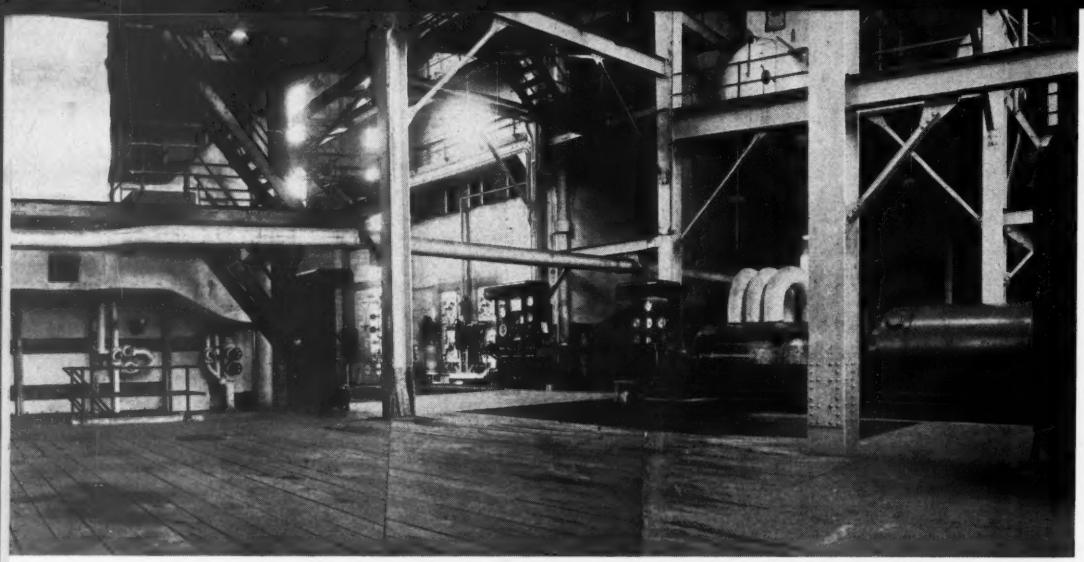


Fig. 1. General view of the station. The forced draft duct to the windbox is clearly visible on the boiler on the left, and a corner of the auxiliary transformer at the extreme right. The deaerating heater is on the balcony over the turbine and the feedpumps are on the main floor behind the turbine

MOUND STREET STATION of the Laclede Power & Light Co. of St. Louis, Mo., was one of the first plants for which definite modernization plans utilizing high pressure superimposed units were made. Although the depression delayed the completion of the project for several years, it is still one of the first of the present flood of top plants to be completed and put into service. The Laclede Power & Light Co. is a unit of the Utility Power & Light system and the engineering work on the new station was done by The Management & Engineering Corp. of Chicago.

The Laclede system serves a large portion of the city of St. Louis with electric power. Much of this load is industrial with a large proportion of refrigeration, which gives the unusual condition of a system peak of about 30,000 kw. in the summer. Mound Street Station is the principal generating station owned by the company and before the new plant was completed had a total capacity of 23,500 kw. made up of: one 3500 kw.; one 5000 kw.; and two 7500 kw. condensing units. A station load as high as 21,000 kw. has been carried.

These units operate at 175 lb. pressure, 480 deg. F. total temperature. Steam was formerly supplied by four 600 and four 500 hp. forced draft chain grate fired and four 500 hp. gas fired boilers. The oldest boilers were installed in 1905 but the four 600 hp. boilers and the three largest turbines were installed between 1920 and 1931.

Station Heat Rate Cut

Because the present building was old and fully occupied by equipment heavily loaded and needed to carry the load, a complete new plant, adjoining the old boiler room on the south, was erected for the high pressure units. This plant, which measures approximately 89 by 114 ft. and 103 ft. from basement to ceiling, houses two 1350 hp., 450 lb., 750 deg. F. gas fired Springfield boilers and one 5000 kw. Allis-Chalmers turbine which exhausts into the low pressure system at 185 lb. This exhaust steam takes care of the two 7500 kw. of turbines and cuts the old station heat rate of about 27,500 B.t.u. per gross kw-hr. to about 18,000. Part of this improvement is due to increased boiler efficiency and part to the top turbine. Space is provided in the building for one more boiler and the plans call for a duplicate boiler room adjoining the present one on the west as shown by the plan drawing.

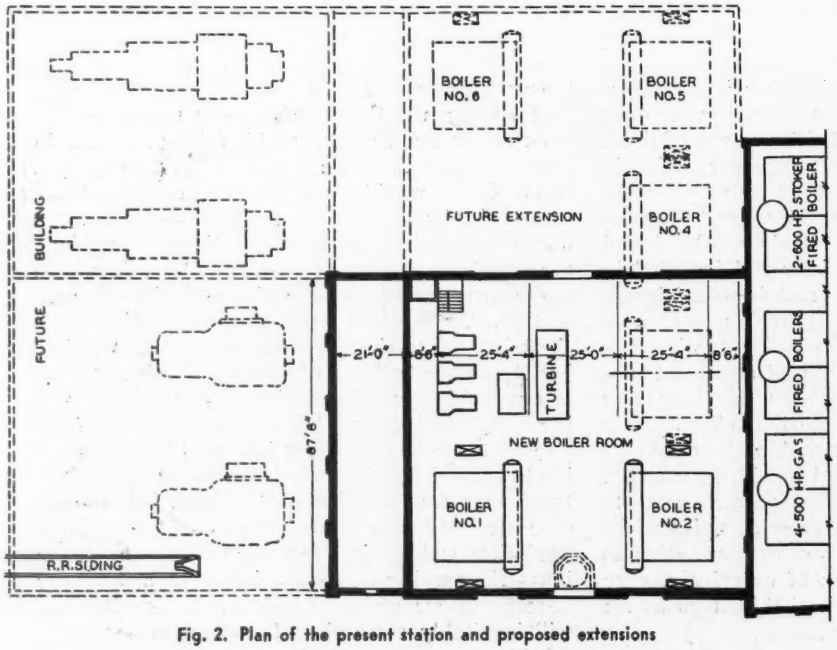


Fig. 2. Plan of the present station and proposed extensions

The new turbine is located immediately adjacent to the boilers. This is a temporary arrangement, part of the plan by which the old equipment will be utilized to best advantage while necessary capacity is added at a reasonable immediate investment and in such a way that the new construction will serve as a permanent part of a complete new station.

So far the additional 5000 kw. of new capacity has reduced the station heat rate

St. Louis Expands

First unit of New Mound Street top plant adds 5000 kw. to Laclede Power & Light Co. system and cuts station heat rate a third. New fan drive gives four speeds with two 1750 r.p.m. constant speed motors

by more than one third. The new boilers will carry the entire installed generating capacity, making it possible to retire the old boilers to standby and peak load service. As the load grows additional generating capacity will be added in a new turbine room south of the boiler room, the switch house for the new station being already built as part of the boiler room. The present top unit generator is now tied in on the old plant bus.

Furnaces are both water and air cooled on three walls to minimize radiation losses and furnace maintenance and give, under normal operating conditions, an air preheat of about 450 deg. F. with an exit gas temperature of about 300 deg. F. Complete automatic control has been provided. Reducing valves and desuperheaters tie the old and new stations together, making it possible to operate the old plant from the new boilers in case the top turbine is down. Provision has also been made for change-over to coal at a minimum expense in case it is necessary to switch fuels in the future. The boiler aisle is wide enough to accommodate coal bunkers, a portion of the breeching is tile lined with provision for stack sprays for cinder elimination, adequate space is available under the boilers (approximately 22 ft.) for ash pits and trenches are provided for ash sluices in the basement floor.

Both of the 7500 kw. units are built for extraction at two points, the third and seventh stages, and the third stage is bled to the deaerating feedwater heater in the new plant. Space is also available for the installation of additional high pressure closed heaters as progress of the station warrants this installation. Due to the present tie up between the old and new plants certain interconnections are also necessary in the condensate and standby oil systems as shown by the flow diagram and oil system piping drawing.

Perhaps the most interesting and novel feature of the plant, however, is the forced and induced draft fan drives by which it is possible to get four fan speeds with two 1750 r.p.m. induction motors. This arrangement utilizing a differential was worked out by S. E. Laramore, chief engineer of the Utilities Power & Light Corp. and the Universal Gear Co.

The smaller of the two motors drives the differential direct through the center unit of two concentric shafts. Running at the same speed as the small one, the large motor, V-belted with a 3 to 1 speed increase, drives the differential through the outer concentric shaft. Both motors are provided with motor driven brakes by which the rotors may be locked. The small motor running with the large one locked, gives ¼ fan speed. The large one running with the small one locked, gives ¾ fan speed. The large motor running

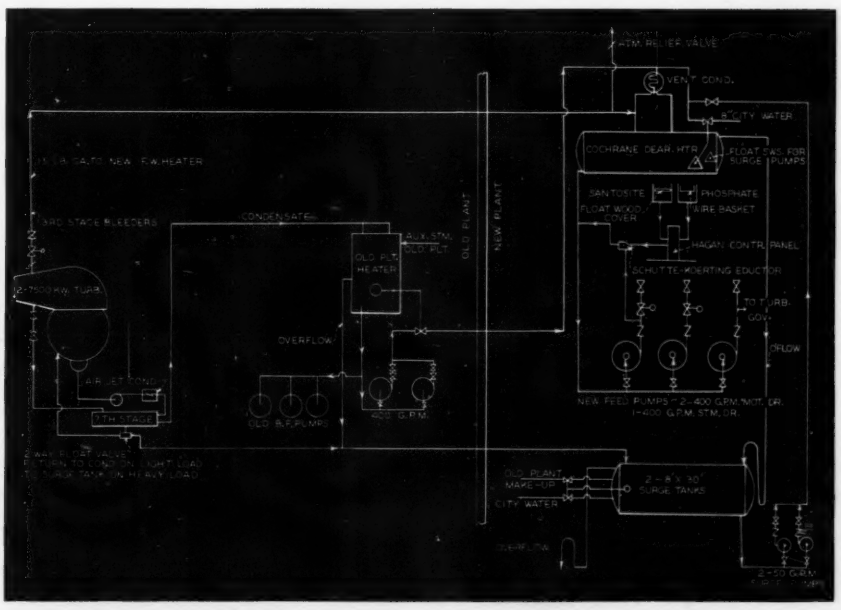


Fig. 3. Diagram showing the condensate and steam hook-up between the old and new stations

with the small motor reversed, gives ½ fan speed and with the small motor running ahead, full fan speed. Space occupied as shown by the photograph is about the same as required for the conventional two motor drive but the space arrangement with both motors on the same side of the fan gives a particularly compact arrangement when both forced and induced draft fans may be located adjacent to each other on the same floor.

With the exception of the water walls and soot blowers both boilers are identical. They are Sprinfields with 13,500 sq. ft. of boiler heating surface, 2550 sq. ft. of Riley water walls, 3780 sq. ft. of Elesco superheater surface and a furnace volume of 13,600 cu. ft. They are baffled for three passes, each fired by four Coen combination oil and gas burners to a maximum capacity of 210,000 lb. per hr. of steam. They are designed for 450 lb. pressure with a superheat ranging

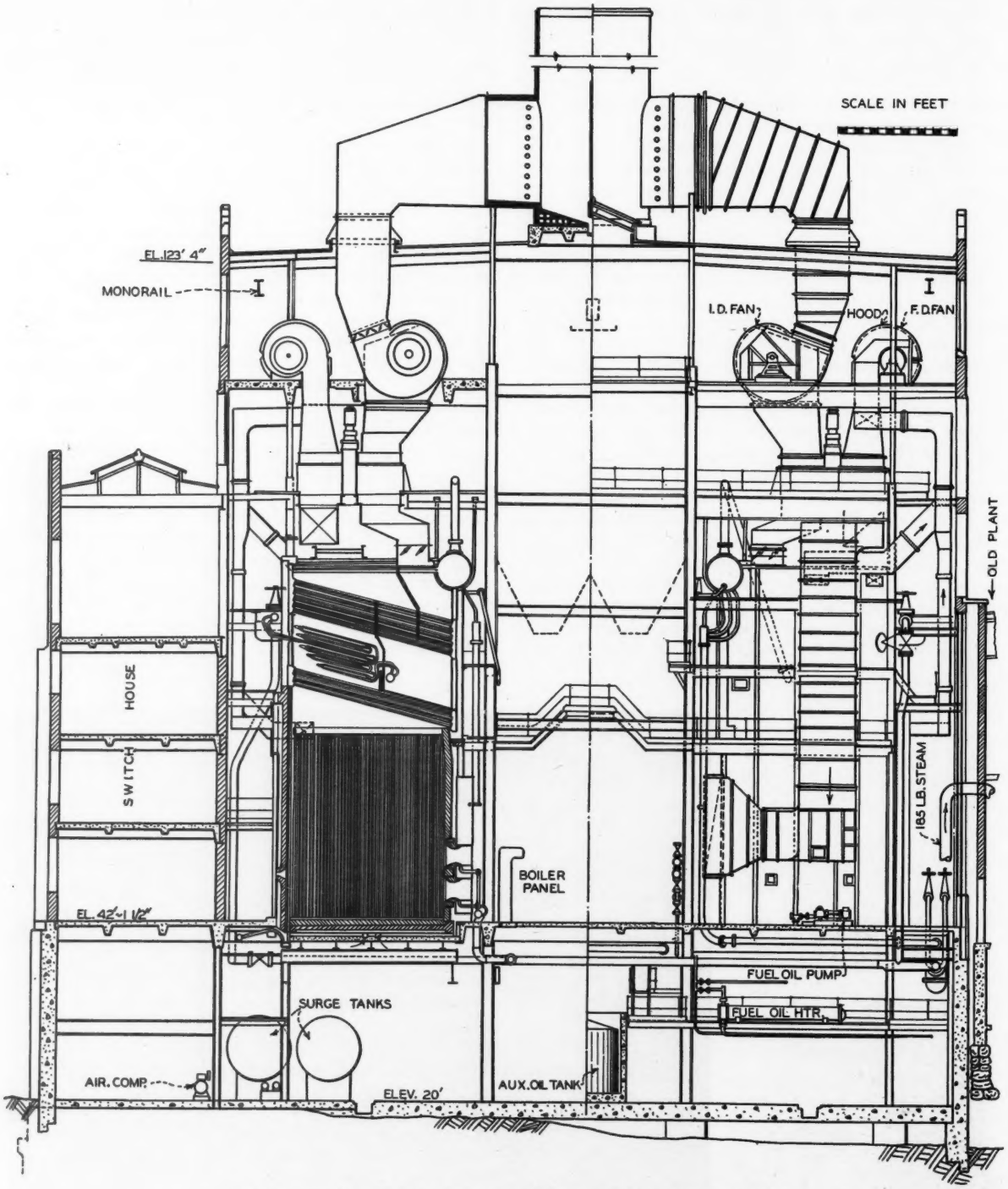


Fig. 4. General cross section through the building. Boiler No. 1 is on the left

from 740 deg. F. to 795 deg. F. No. 1 unit has Lacleede-Christy air cooled walls and Bayer soot blowers; No. 2 has Detrick air cooled walls and Diamond soot blowers.

As shown by the sectional drawing the water walls are fed by downcomers which drop vertically from each end of the drum to the floor where they turn, circle the boiler, and join in back. This header is connected at frequent intervals by flexible leads which feed three box headers, one on each side and one on the back. The water wall tubes, straight 3 in. O.D. on $5\frac{5}{16}$ in. centers, rise vertically from these headers and cover the bottom 23 ft. of the furnace. At the top the back wall tubes tie directly into the boiler, the side wall tubes into box headers exposed to the furnace as shown. The risers come out of this header vertically, extend upward about 18 in., cut out diagonally through the boiler wall and extend upward to the drum on the outside of the setting.

Furnace Floor Air Cooled

The furnace floor, isolated from the walls, consists of an 8 in. concrete slab resting on I-beams and carrying 4 in. of air cooled tile, 6 in. of Silocel, $4\frac{1}{2}$ in. of second quality and 9 in. of first quality fire brick. Air is taken in through registers in the bottom slab to cool the floor and then passes upward through the back wall. Air for the side walls is taken from the space between the ring header and box headers feeding the water walls.

All of the rear wall and a portion of the side wall air is bled off at the top of the water walls into ducts (one on each side of the boiler) which terminate in hoods partially covering the inlets to the double inlet forced draft fans. The balance of the side wall air continues upward to the top of the setting. The duct and hood arrangement is clearly shown on the right hand boiler (No. 2) of the plant section. The fan suction gives the necessary circulation which may be controlled by dampers in the ducts.

Forced draft air needs, beyond that supplied from the walls, is taken direct from the top of the boiler room and discharged downward through the air heater. The duct then splits and one branch runs down each side of the boiler to the level of the burners, where they turn at right angles and join in the windbox. One of these ducts is shown in the elevation of boiler No. 2 on the plant section and the other one of the same boiler on the left hand side of the boiler room photograph.

Forced draft fans are Sturtevant double inlet turbovanes with a capacity of 83,700 c.f.m. at 7.7 in. H_2O and 850 r.p.m. Each fan is driven by a 40 and a 125 hp. motor through the Universal differential gear as explained earlier. Induced draft fans are Buffalo

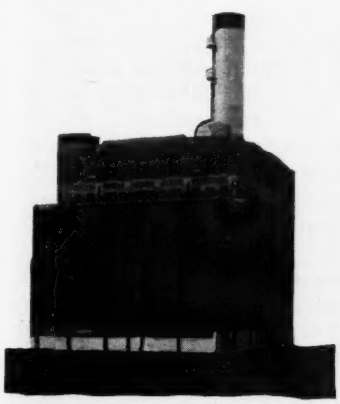


Fig. 6. Mound Street Station

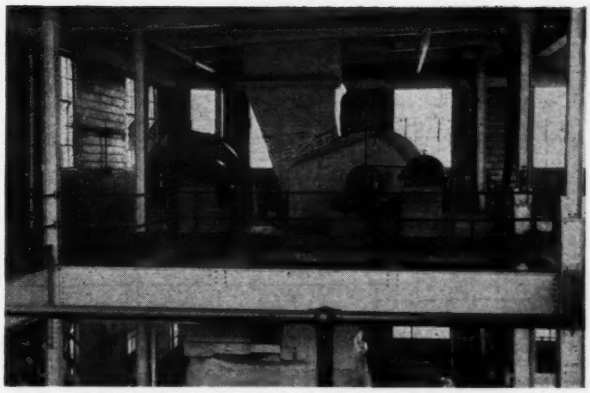


Fig. 5. Both forced and induced draft fans are on the top level. The drive used gives four fan speeds with two constant speed motors

duplex conoidal with a capacity of 125,000 c.f.m. at 7 in. H_2O and 404 deg. F. and 850 r.p.m. These fans are driven by 50 and 150 hp. motors. All motors are 440 v., 1760 r.p.m. Howell self-starting induction motors. The small motors have General Electric thrustor operated brakes and the large motors, Cutler-Hammer motor driven brakes.

Changes of fan speed are manually controlled from the boiler panel and all fans are equipped with Cutler-Hammer centrifugal switches to form an interlock with the combustion control system. Failure of the induced draft fan trips the forced draft fan and this in turn cuts off the fuel.

Combustion control is the Leeds & Northrup low pressure pneumatic type with CO_2 compensation, which, in operation, is maintained at from 10.5 to 11 per cent; 11.7 per cent being the theoretical limit with the 975 B.t.u. natural gas being burned. Steam header pressure actuates a controller on the master panel and loads the fuel controller and air flow controller on each of the two boiler panels to control the gas flow and induced draft fan damper. Furnace draft, by means of a damper in the forced draft duct, is maintained by independent controllers. Air-fuel ratio may be adjusted, and transfer to manual control made, from the boiler panels. Fan speed is changed manually, also, from the boiler panels. No manual control equipment is provided on the master panel. This system was described in detail in the April, 1936, issue of Power Plant Engineering, page 226. Constant steam pressure compensation is provided on the master, but this is not used, the plant being operated with a drooping pressure characteristic. CO_2 compensation from a Leeds & Northrup electric type meter is through a solenoid coil on the fuel controller.

Instruments and Flow Meters

Complete instrumentation is provided by Crosby indicating pressure gages, Republic flow meters on all gas, steam and water, and Leeds & Northrup multipoint recording pyrometers, all mounted on either the master or boiler panels. Other boiler equipment includes Yarway water columns and gage glasses with Crouse-Hinds illuminators, Edward blowoff valves, Walworth stop valves, Crosby safety valves, Swartwout S-C feedwater regulators, excess pressure regulators, boiler feed and oil pump governors, Walworth gas, steam, water and oil valves, and Edward steam

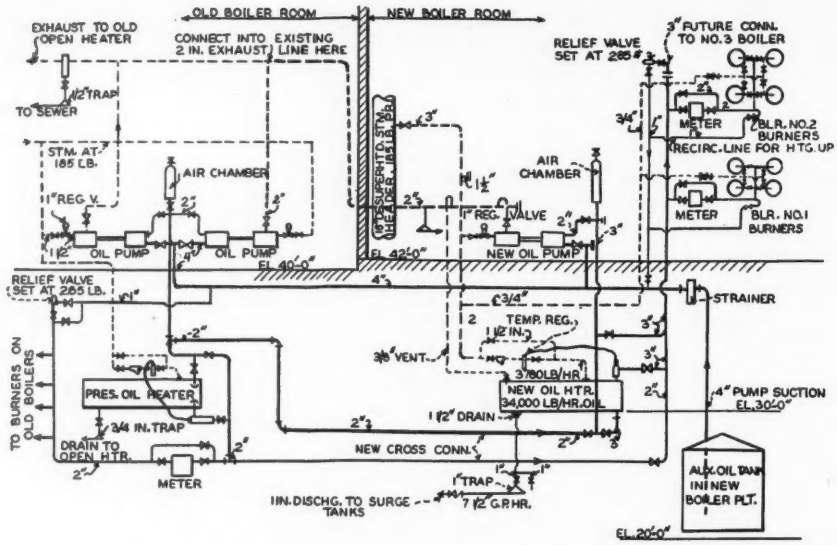


Fig. 7. Fuel oil is used as standby for both the old and new stations but the two systems are separate

valves. The standby fuel oil system is shown in detail by the drawing. An oil storage tank, 8 ft. in diam. and 8 ft. high, is provided in the basement for immediate needs; main storage tanks with a capacity of 200,000 gal. are located outside. Continuous blowdown, through a heat exchanger in the old plant, is provided, blowdown being regulated in accordance with the readings of a Leeds & Northrup conductivity meter. All high pressure drains go through Armstrong traps to the surge tanks in the basement. Carey insulation was used throughout, both on the boilers and steam lines.

Steam piping is laid out with both the needs of the ultimate station and old station in mind. In addition to the Crosby drum and superheater safety valves, the main steam header is protected by a Spence 4 in. power valve. The new boilers may feed the old station 185 lb. main through duplicate Spence reducing valve and desuperheater stations, each of which will handle the output of one boiler. The 185 lb. system is protected by two safety valves at the turbine, two at the exit of the line from the new plant and two in the old plant. These are all 4 in. Crosbys.

The top generating unit is a 5000 kw., 3600 r.p.m., 4500 v., 3 ph. 60 cycle, 0.8 p.f. Allis-Chalmers turbo-generator operating between 450 lb. 750 deg. F. and 185 lb. It is separately excited from the old plant exciter bus. The turbine has an Andale oil cooler and a Griscom-Russell generator air cooler supplied with water from the old plant through an Elliott strainer. Auxiliary power at 440 v. is supplied by an Allis-Chalmers 1000 kv-a. three phase transformer located in the boiler room. All auxiliary breakers are Westinghouse Type AB, the only equipment except the machine shop at present occupying the switchhouse.

Fig. 8. Three 3600 r.p.m. feedpumps are installed, two motor and one turbine driven

Of necessity, the two plants are tied together as shown by the water flow diagram. In the new plant three 400 g.p.m., 1365 ft. head, 3600 r.p.m. Worthington boiler feed pumps are installed, two driven by Allis-Chalmers 200 hp. line start induction motors, and one, by a 181 hp., 450 lb. turbine. This turbine and the Dean Bros. $7 \times 4\frac{1}{2} \times 10$ in. fuel oil pump exhausts to the new Cochrane open heater. The oil pump is located on the firing floor adjacent to No. 2 boiler and the Alco oil heater on the level below.

Control of the condensate system is shown on the drawing. Condensate from the old plant heaters is pumped to a 375,000 lb. per hr. Cochrane deaerating heater (with vent condenser for 15 lb. ga. operation) with overflow to two 8 ft. diam. 30 ft. long surge tanks in the basement. Makeup from these tanks is pumped back to the deaerating heater by two Allis-Chalmers 3600 r.p.m. pumps operated from mercoid switches on the upper float. The lower float admits city water makeup which is used in preference to river water. The Hall system of boiler water treatment is used with phosphate and Santosite injected into the boiler feed pump section by a Schutte & Koerting water eductor as shown. Condensate for gland sealing on the turbine is pumped to an elevated tank by a Westco pump driven by a float controlled ¼ hp. Century motor. Two Chicago Pump Co., sump pumps driven by 5 hp. Baldor motors with Square D float switches are located in the basement.

All floors with the exception of the basement and firing level are made of Bates grating and all levels from the basement to the roof can be reached by a Harnischfaeger 5 t. electric monorail hoist, the rail of which entirely circles the boiler room just under the roof.

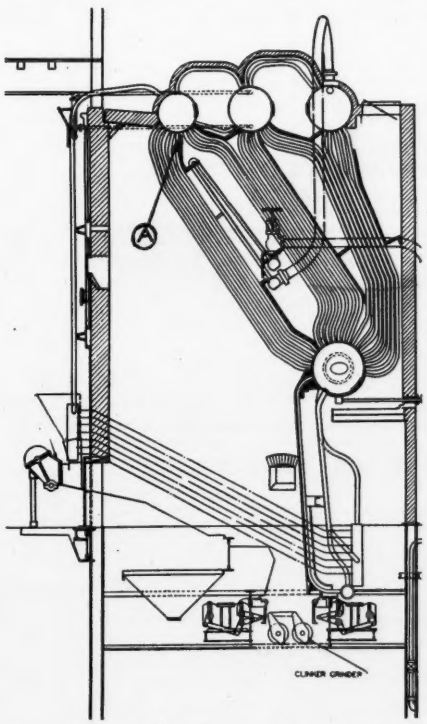
Proper Baffling Eliminates Smoke

By D. S. Clark,
Purdue University,
Lafayette, Ind.

WHEN considering the location of an isolated power plant, the problem of refuse emitted from the stack is of major importance, particularly if the plant is to be located in or near a residential district or in a location affected by ordinances directed against the pollution of the atmosphere. Sometimes developments require the enlargement of plant facilities; and new equipment, necessary to carry the increased load, is ordinarily expected to operate under higher efficiency than the older equipment without introducing any undesirable effects. Accordingly, the following experiences may prove of help and interest to other plants.

A plant was operating successfully, creating a negligible amount of smoke until load conditions made it imperative to enlarge the capacity. Multiple-drum, bent-tube, three pass boilers with convection superheaters between the first and second banks of tubes were installed with underfeed stokers. The draft equipment was handling fluctuations in load very satisfactorily. The old stack had been designed for the projected increased capacity and building space requirements were determined when the plant was originally designed.

New equipment was of the same general type previously installed about 10 yr. earlier. Improvements in the boiler design, however, permitted steam generators of approximately 30 per cent more heating surface to occupy the same space and head room allowed for the old boilers. The superheat was also increased from 100 to 150 deg. F. In addition, water walls were installed with the new boilers whereas they were not in the old installation. The same draft equipment was used and improved underfeed stokers were installed.



Cross section of boiler and baffling. A shows the baffle that was changed. When the top was removed the smoke nuisance vanished

Smoke

As soon as the new equipment was placed in operation the smoke nuisance was apparent. The first thought was that the water walls might be the cause. Water walls, however, operated satisfactorily in other plants and there was no reason to suspect that they would introduce smoke in this plant. Naturally smoke might have been caused by the stoker operation or by the boilers.

After it was found that the problem had to be solved by the plant staff, the decision was reached to change the baffling in the new boilers, starting with the back baffles and working toward the front. The baffling back of the last (third) bank of tubes was removed without any effect upon the smoke; then the shelf baffle back of the second bank of tubes was removed without any apparent effect upon the smoke. Further changes were made with extreme care to preserve the circulation of hot gases.

Practically all of the hot gases, after passing the first bank of tubes had to pass through the convection superheater which is located back of and parallel to the first bank of tubes. Baffles extended from the superheater header to the top of the mud drum and from the top of the superheater to the bottom of the front drum. The superheat at low loads was greater than required for the turbine operation. (Increased loads tend to increase the superheat with the convection type of superheater.)

It was decided to remove a section of the baffle between the superheater and the front drum. Eighteen inches was removed from the top of this baffle extending the full length of the drum (slightly over nine feet). This boiler was again put on the line and failed to create any appreciable smoke, but the superheat decreased below that deemed necessary for turbine operation. In the next boiler, which is located between the first and the stack, a section of the baffle below the front drum was removed, but only 16 in. was taken off the top. This did not reduce the superheat below that considered essential for satisfactory turbine operation but did conquer the smoke problem. The baffling in the first boiler was then reconstructed to increase the superheat without making more smoke.

In addition to the reduction in smoke, other effects were noticed. The temperature of the flue gas and the per cent CO_2 were only slightly increased over former operation. The boilers are now able to pick up a load more quickly. The balanced draft system now operates with higher air pressure under the fire than formerly and the fuel bed has been freer from holes than it was before the removal of the section of the baffle mentioned. It may be expected that the efficiency will be slightly increased and that a heavier load can be carried than was practicable before the removal of the baffle.

Hot Oil Process Heating System

Where high temperatures and low pressures are required oil as a heating medium has advantages over water and steam

By James O. G. Gibbons

ENGINEERS engaged in boiler plant design are occasionally confronted with a problem for which no economical solution may be found through the use of steam. This being the case, it will not be out of place to describe briefly a comparatively small installation, using oil as a medium of heat transfer, in the design of which the writer took a leading part.

The plant which had recently changed hands, already had a steam boiler suitable for 125 lb. pressure, and a separately fired superheater. The first thought was naturally given to the possibility of using these to furnish heat at the required temperature (450 to 500 deg. F.) for the jacketed kettles, and other equipment.

Immediately it became apparent that there were at least two serious objections to the use of high pressure superheated steam, the first being that only the peak of the temperature curve could be usefully employed, there being no demand for steam at lower temperatures, except of course, the small amount that could be used for feedwater heating.

This entailed the total loss of a large part of the

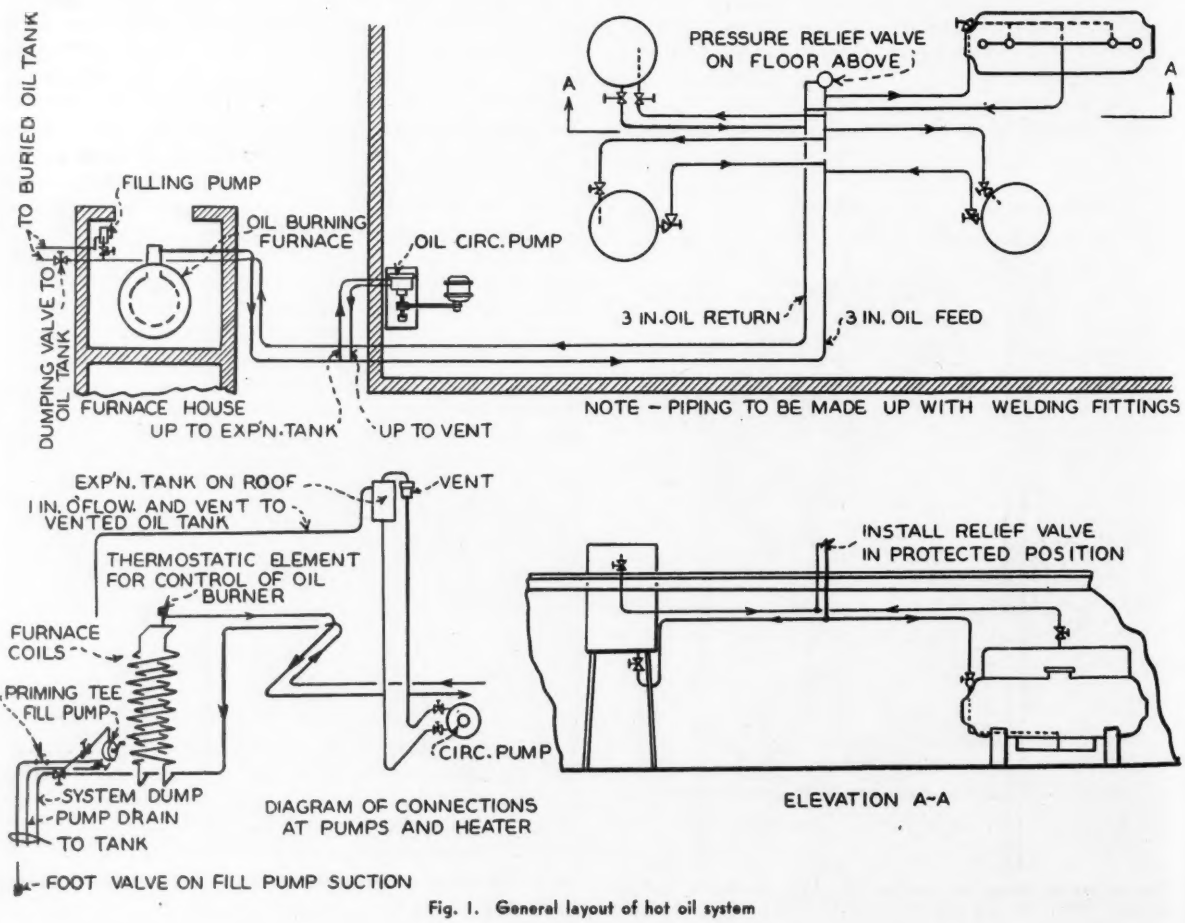


Fig. 1. General layout of hot oil system

heat generated, and pointed to the necessity of making every possible effort to develop a less wasteful method of operation.

The second objection, almost equally serious, was that most of the equipment possessed by the new owners was not designed to withstand high pressures.

Use of steam being rejected, it was decided to make use of hot oil as a medium of heat transfer, especially as it was ascertained that oil which would withstand the required temperature without giving trouble, was commercially available.

It may be stated at the outset, that the problem of designing an installation for heating with hot oil as a medium, is no more mysterious or complicated than that of designing a satisfactory hot water heating system for a residence. The writer has had experience with both, and of the two he would prefer to tackle an oil heating job, as there are not so many chances for unsatisfactory circulation.

This statement is made because there has been a tendency to overemphasize the engineering difficulties connected with a hot oil heating system, although there are two things which must be kept in mind, the first being that accumulations of gas must be eliminated, and the second and most vital one, that the system must be absolutely tight, not so much on grounds of successful operation, as because a discharge of hot oil is highly dangerous.

Tin melts at about 455 deg. F. and if the pipes were carrying molten tin, the danger would be recognized by everyone, and there is probably not much difference between being struck by a stream of molten tin and a stream of hot oil at the same temperature, except that the oil has a much higher specific heat which apparently would not help matters.

Systems such as that described are operated at pressures only sufficiently high to keep the oil in circulation, so with careful welding, standard steel pipe should have ample strength, although in this particular case, to allow for any damage which might be done through faulty welding extra heavy pipe was used, however all valves and fittings should be steel, and as far as possible, all joints welded.

Care should be taken that the circulating pump is designed for high temperatures, and where there is the slightest danger of a leak, especially at overhead valves, drip pans and other guards should be provided so that there will be no danger from hot oil drips.

With the application of common sense safety methods of design and operation, there should be no more danger from a hot oil system than from a high pressure steam system.

It is well to remember that the specific heat of oil is only about 0.5 and we have not a great temperature differential to play with, so efficient insulation of the oil lines is desirable.

In the case described, the oil was heated by an oil fired furnace containing two steel pipe coils connected in parallel, as indicated in Fig. 1. The coils being made of extra heavy pipe with all joints welded.

For filling the system from an underground tank, a small hand pump was used but of course a motor driven pump might have been better, and any overflow from the system was returned to the tank. A motor operated rotary pump was installed for circulating the hot oil through the system, and both the heating coils and the expansion tank were connected to the suction side of the pump.

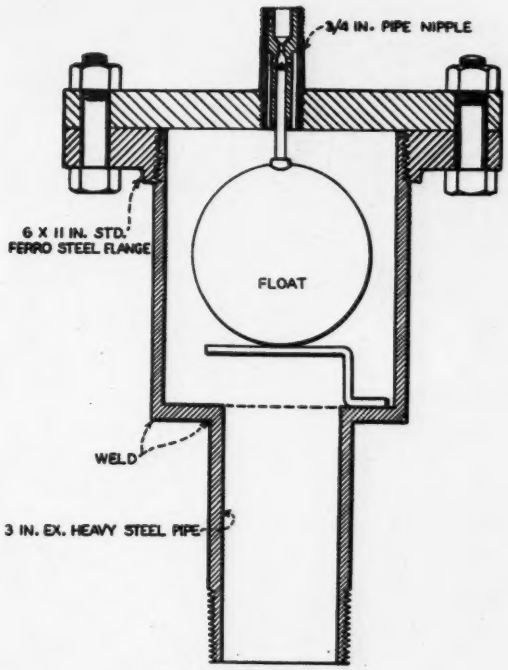


Fig. 2. Detail of gas vent

By this means, the heating coils, which really constituted the most dangerous part of the system, operated under the lowest possible pressure, the minimum pressure being that due to the level of the oil in the expansion tank which was installed on the roof of the building as indicated on Fig. 1, this pressure being practically constant for any given temperature, as it was unaffected by the discharge pressure of the pump. The overflow and air vent from the expansion tank were run to the underground oil tank which was itself vented to the atmosphere.

The gas vent shown on Fig. 1 and illustrated in detail on Fig. 2, was connected to the top of the expansion tank which not only provided a passage for the gas to the atmosphere through the oil tank vent, but took care of any oil which might leak through so that it could not escape from the system.

The gas eliminator was operated by a ball float as shown in Fig. 2, which opened the vent when the oil level was forced down by an accumulation of gas at the top. The operation was entirely satisfactory, but further consideration leads the writer to believe that it would be at least equally so if the float were left out and a small constant leak maintained between the gas eliminator and the expansion tank.

IN THE EXHIBIT of Power and Mechanical Engineering equipment, Nov. 30 to Dec. 5 in Grand Central Palace, New York City, operating exhibits will be featured, including automatic stoker feed to compare conical distribution with flat type chutes, combined wet and dry-bulb thermometer control for air conditioning, unit heaters and air conditioners.

WELDING

By
B. D. LANDES
Engineering Service Dept.
A. M. Byers Co.

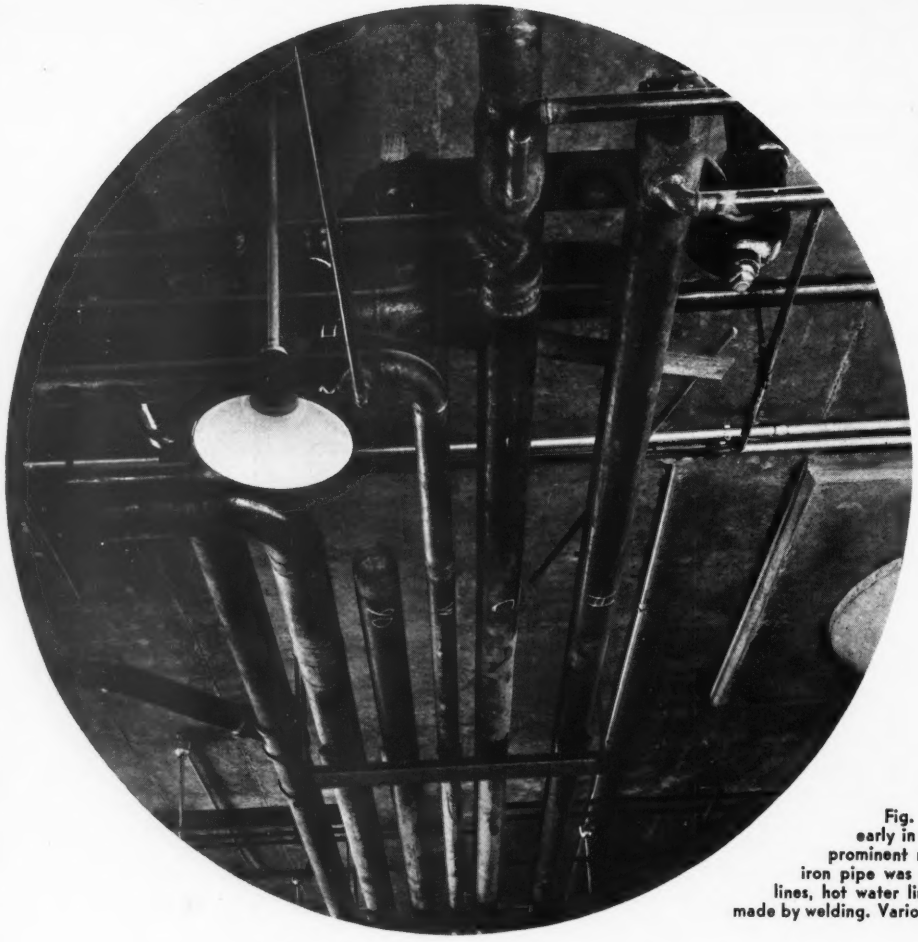


Fig. 1. Some of the wrought iron pipe installed early in 1936 in a new beef slaughter house built by a prominent meat packing company in Chicago. Wrought iron pipe was used for various services including cold water lines, hot water lines and steam lines and all of the joints were made by welding. Various types of welds are shown to advantage above

RAPID INCREASES in the utilization of wrought iron products for various applications where fabrication is accomplished by welding and the fact that wrought iron differs both physically and chemically from other ferrous metals suitable for welding, have made it desirable to establish recommended procedures to follow when welding wrought iron by the commonly used processes. Wrought iron is easy to weld but in order to obtain the best results the welding engineer should be thoroughly familiar with the material and its characteristics which influence weldability.

Slag Content 1 to 3 Per Cent

Wrought iron is a two component metal consisting of high purity iron base metal and iron silicate. The iron silicate is a glass-like slag. These two materials are in physical association, as contrasted to the chemical or alloy relationship that generally exists between the constituents of other ferrous metals.

The iron silicate or slag content of wrought iron varies from about 1 per cent to 3 per cent or 3½ per cent depending upon the type or class of product. In the form of plate, for example, it usually amounts to about 3 per cent by weight. This constituent is distributed throughout the iron base metal in the form of threads or fibres which extend in the direction of rolling. The slag fibres are distributed so thoroughly throughout the iron component that there may be 250,000 or more to each cross-sectional square inch of finished material. This confers on the material a definitely fibrous structure which can be observed readily if a piece is nicked and fractured.

Each of the two dissimilar materials that go to make up wrought iron has its own fusion temperature. The iron base metal, because of its low metalloid content, fuses at a temperature of about 2730 deg. F., which is somewhat higher than the melting point of low and medium carbon steels. The slag component fuses at temperatures between 2100 and 2200 deg. F., or several hundred degrees lower than the base metal.

The purity of the base metal gives wrought iron the ability to withstand higher temperatures than other ferrous metals and, in general, it should be worked hotter for best results. Also, the protection afforded the metal during heating by the fluxing action of the slag has a beneficial effect in producing sound welds. This is a particularly important factor in making plastic welds.

Processes and Procedures

Wrought iron can be welded easily by any of the commonly used processes, such as forge welding, electric resistance welding, electric metallic arc welding and gas or oxy-acetylene welding. The first two, of course, come under the classification of plastic welding, while the latter two are classed as fusion processes.

When welding wrought iron by either the forge or the electric resistance methods, the important point to keep in mind is that the metal must be worked somewhat hotter than steel. In forge welding, for example,

# of WROUGHT IRON

wrought iron is worked at what is termed a "sweating heat", which corresponds to a temperature of about 2500-2550 deg. F.

Plastic welding has been employed for many years with wrought iron. In fact, all standard wrought iron pipe and a majority of the large O.D. wrought iron pipe is produced by forge welding, which embraces both roll and hammer welding. Resistance welding has been employed in fabricating wrought iron installations.

Oxy-acetylene and electric metal arc welding are the two most generally used fusion processes. Successful welding with either process is accomplished only by following carefully the correct procedure. This is true regardless of the type of metal to be welded.

Due to the widespread use of fusion welding in industry and the importance of wrought iron, especially for those applications where resistance to corrosion is important, recommended procedures for welding wrought iron became necessary both from the standpoint of the user and the manufacturers of the material. This need resulted in a comprehensive series of tests conducted by the National Weld Testing Bureau and sponsored by A. M. Byers Company. The American Bureau of Shipping and Lloyd's Register of Shipping also conducted tests to determine whether or not wrought iron plates could be welded in accordance with their requirements. Results of these tests, summarized by the Engineering Service Department, A. M. Byers Company, are presented in the accompanying article which includes specific recommendations that will enable a competent welder to produce welds that will meet the X-ray requirements of the A.S.M.E. Boiler Construction Code for Class I welds.

Furthermore, the exact procedure used with one metal may not produce the best results if used with a different metal.

Fusion Welding

Although both the oxy-acetylene and the electric metal arc processes have been employed extensively in making welded wrought iron installations, very little research work was done until recently to establish the details of the procedure to follow in each case. A comprehensive series of tests was completed a short time ago and the results are given in the following portion of this article.

The rapid increase in the use of wrought iron plates for marine equipment led the American Bureau of Shipping and Lloyd's Register of Shipping to conduct a series of tests to determine whether or not wrought iron would meet the welding requirements established by each organization. These tests involved fusion welding of wrought iron to wrought iron and wrought iron to steel. As a result both organizations have approved the weldability of wrought iron plates.

Manual Oxy-Acetylene Welding Procedure

The procedure for welding wrought iron by the manual oxy-acetylene process is practically the same as that followed in welding mild steel of the same thickness. However, one important point to keep in mind is that the iron silicate or slag included in the metal melts at a temperature which is below the fusion point of the iron base metal. The melting of the slag gives the surface of the metal a greasy appearance. This should not be mistaken for actual fusion of the base metal, and therefore, heating should be continued until the iron is fully melted.

The best oxy-acetylene welds are produced when perfect fusion is obtained without excessive mixing of the parent metal with the weld metal. Too much rubbing or agitation of the molten metal causes the forma-

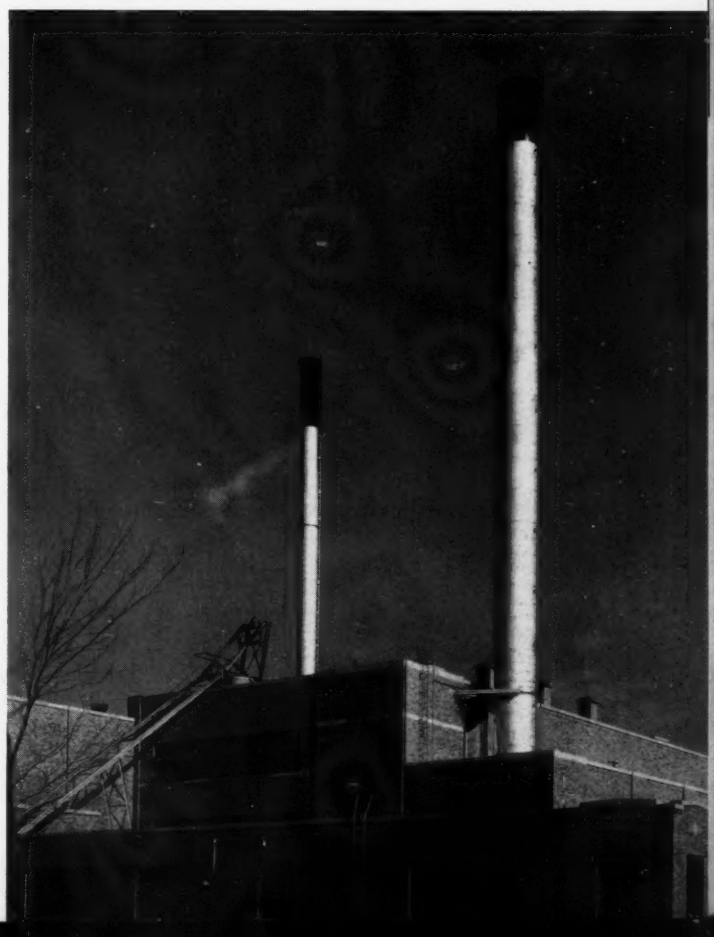


Fig. 2. All welded wrought iron smokestacks erected early in 1936 at the Calumet Sewage Disposal Plant, Chicago. The large stack in the foreground is 7' 4" in diameter x 115' high, fabricated of 1/4" and 3/8" plates and conveys waste gases from the incinerator. The smaller stack serves the heating boiler and is 42" in diameter x 85' high, fabricated of 5/16" plate

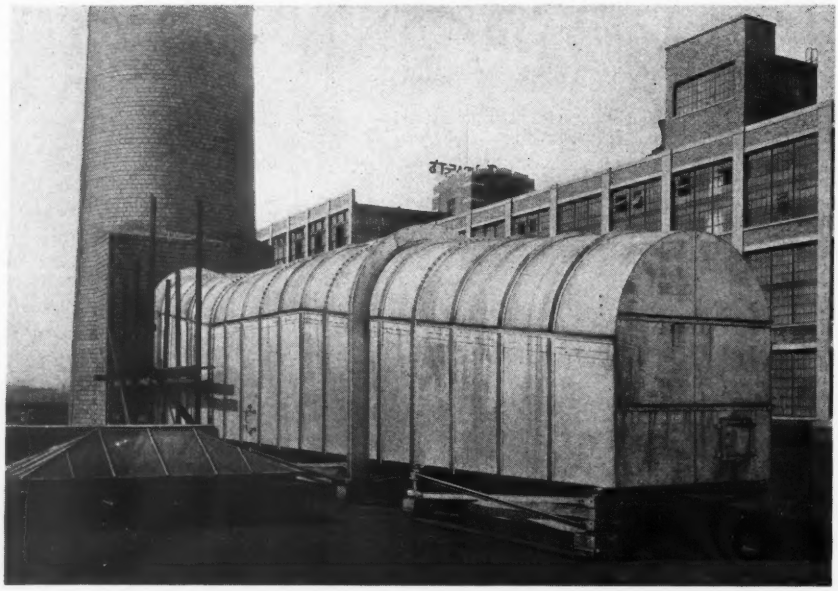


Fig. 3. Welded wrought iron boiler breeching installed April, 1935, at a large candy manufacturing plant in Boston. Details of the construction and design, the cleanout doors in end and side, roller supports in channels to take care of expansion and light weight foundation are worth close study

tion of oxides which may be trapped in the weld. Ordinarily, just enough of the parent metal should be fused to provide a sound bond with the filler material.

The selection of welding rod material is important. It is advisable to use a rod that has a yield point near that of wrought iron (27,000-30,000 lbs. per sq. in.) and to avoid rods containing high carbon or alloys intended to increase the yield strength. In general, any high quality low carbon rod will give entirely satisfactory results.

Table I gives the essential details of the procedure to follow in manual oxy-acetylene welding of wrought iron. This procedure was found to produce welds of a quality to conform to the X-Ray requirements of the A.S.M.E. Boiler Construction Code for Class I welds. However, other procedures may be employed that should produce welds that are just as satisfactory.

Manual Metallic Arc Welding Procedure

In welding wrought iron by the electric metal arc process the best welds are produced when the welding speed is decreased slightly below that used for the same thickness of mild steel. This procedure is desirable because with reduced speed the pool of molten metal immediately following the arc is kept molten for a longer period of time, thus making for more complete elimination of the gases and affording the entrained slag an opportunity to float out of the weld metal.

Also, it may be necessary to employ a slightly lower current value than that used with the same thickness of mild steel, particularly in welding thin sections where there is a possibility of burning through the material.

Excessive penetration into the face of the parent metal should be avoided. The penetration should be no greater than that required to obtain a sound bond between the deposited metal and the parent metal because fusion of an excess quantity of the parent metal tends to carry slag into the weld metal.

In metal arc welding, as in gas welding, the choice of filler metal is important. Any good quality rod either coated or bare can be used with wrought iron, but in general the coated rods are used more extensively in current installations.

The welding procedure found to produce very sound welds is given in Table II. Other procedures may give equally satisfactory results. For certain classes of work where a greater degree of porosity may be permitted, larger electrodes, higher currents and higher speeds may be used.

Table III gives the recommended rate of travel of the electrode in inches per minute that was found to produce good results. With manual operation it is practically impossible to maintain accurately a given speed, but the proper rate can be closely approximated by timing the actual rate of travel with a stop watch and then making any adjustments necessary.

In manual metal arc welding, as in gas welding, it was found that welds of a quality to conform to the X-Ray requirements of the A.S.M.E. Boiler Construc-

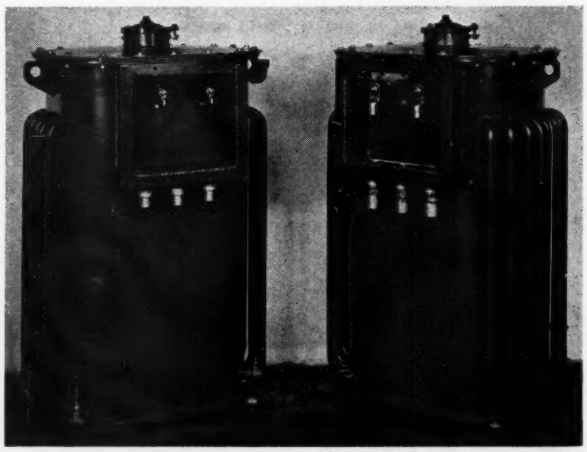


Fig. 4. Subway transformers, 100 kv-a., built 1935 for installation by the U. S. Engineers at Lock and Dam No. 20, Canton, Missouri. The tanks, covers and cooling oil radiation tubes were fabricated from wrought iron plates and wrought iron pipe using all welded construction

tion Code for Class I welds can be made in wrought iron.

TABLE I

Manual oxy-acetylene welding procedure

Thickness of Plate	1/8	1/4	3/8	1/2	5/8	3/4	7/8	1
Type of Joint				Single V				
Angle (from perpendicular)	30	40	40	40	40	40	40	40
Included Angle	60	80	80	80	80	80	80	80
Spacing between Edges (Starting End)	1/32	1/16	1/16	1/16	1/16	1/16	1/16	1/16
Spacing between Edges (18" from Starting End)	1/8	3/16	1/4	1/4	1/4	1/4	1/4	1/4
Diameter of Filler Metal (1st Side)	1/8	3/16	1/4	1/4	1/4	1/4	1/4	1/4
Diameter of Filler Metal (Root Side*)	1/8	3/16	3/16	3/16	3/16	1/4	1/4	1/4
Tip Size **	6	8	9	10	11	12	12	13
Oxygen Pressure **	12	16	18	20	22	24	26	28
Number of Layers—1st Side	1	1	1	2	3	3	4	5
Number of Layers—Root Side*	1	1	1	1	1	1	1	1

* When a double weld is required, as for example under the A.S.M.E. Code, Par. U-68, or U-69, a root Bead is used.

** Tip sizes and oxygen pressures are for Oxweld blow pipe No. 17. The acetylene pressure may be any value from zero to 5 pounds. For other types of blow pipes use the tip size, oxygen and acetylene pressure recommended for steel of the same thickness.

TABLE II

Manual metal arc welding procedure

Thickness of Plate	1/4	3/8	1/2	5/8	3/4	7/8	1
Type of Joint	Single V	Single V	Single V	Single U	Single U	Double U	Double U
Angle (from perpendicular)	30°	30°	30°	9°	9°	9°	9°
Included Angle	60°	60°	60°	18°	18°	18°	18°
Radius	None	None	None	1/4	1/4	1/4	1/4
Tongue	0 to 1/16	0 to 1/16	0 to 1/16	3/32	3/32	3/32	3/32
Spacing between Edges	3/32	3/32	3/32	None	None	None	None
Number of Passes	3	4	5	6	8	9	10
Diameter of Electrodes	3/16	3/16	3/16	3/16	3/16	3/16	3/16
Amperes	170	170	180	180	180	180	180

TABLE III

Recommended rate of travel of electrode in in. per min. for manual metal arc welding

Plate Thickness	1/4	3/8	1/2	5/8	3/4	7/8	1
1st Layer—1st Side	8	8	7	7	7	6	6
Intermediate Layers—1st Side	5	5	5	5	5	5	5
Last Layer—1st Side	5	5	4	4	4	4	4
1st Layer—2nd Side	5*	5*	4*	4*	4*	6	6
Intermediate Layers—2nd Side						5	5
Last Layer—2nd Side						4	4

*Not used unless a double weld is specified.

Red Cross Nurses Promote Health

LATE LAST FALL eight Red Cross nurses were sent to Spencer County, Kentucky, to coöperate with the State Board of Health in blotting out an epidemic of typhoid fever which had spread alarmingly before its seriousness was appreciated. Spencer County is a rural region and these Red Cross nurses had to wade creeks, use boats, travel through the woods, over railroad trestles and across swinging bridges to reach their patients, carrying with them pails to wash clothes, chlorinated lime, nightgowns, blankets, soap, towels—everything that the stricken family might need.

In the past twelve months 700 Red Cross public health nurses have made more than a million home visits to patients. They have gone into schools and inspected more than 600,000 children, detected defects before serious complications set in and sent many children to doctors, dentists and oculists for corrections that have made school work easier and safeguarded future development. Instructing children in health habits has become an increasingly important phase of the school work of Red Cross public health nurses.

In addition to the more than 700 full time Red Cross nurses there are nearly 2,000 Red Cross nurses working in hospitals and institutions or employed on private cases who devote a part of their time to teaching home hygiene and care of the sick to classes in their locality. This program is designed to teach people to help themselves, their families and friends in giving intelligent sick room care in instances where the services of a trained nurse are not required. It is

one of the most important nursing activities of the Red Cross because through such instruction it is possible to reach thousands of homes to which Red Cross nurses can not find time to make personal visits. In many of the more sparsely settled areas of the country a single nurse's territory may include several hundred square miles and it is obviously impossible for her to cover all parts of it every day. But by carrying on classes in home hygiene and care of the sick at central points she can reach the majority of homes in the area and still have time to make bedside visits to those patients who most need her.

The Red Cross is dependent upon membership dues each year to administer its nursing services and to carry on its work of disaster, veteran and civilian relief. You can share in the work of the Red Cross by enrolling as a member and your dues will support its programs. Join during the Roll Call, November 11 to 26.

THREE UNITED STATES TREASURY checks totaling $129,460.24, to cover the cost of administering the unemployment compensation laws of Idaho, Oregon and Indiana, have been issued, the Social Security Board announced. Idaho's check is for $31,251.05. Approximately 50,000 employees working for 7,500 firms are estimated to be covered by the Idaho unemployment compensation law. Oregon receives $29,660.19. About 200,000 workers employed in 15,000 firms are covered under this law. The check to Indiana is for $68,549.00. Approximately 750,000 workers employed in 10,000 firms are covered under this law.

ELECTRON TUBES— Principles and

PART X

HAVING DESCRIBED the effect of the presence of gas in a thermionic tube, we shall now return to the high vacuum tube and continue our discussion of its properties. To present this discussion properly it will be necessary and incidentally interesting to consider, briefly, a little more of the history of the electron tube.

The electron tube, as has been explained, had its birth and passed its childhood, so to speak, in the radio field—the field of wireless telegraphy as it was known then. The term "radio" did not come into general use until around 1920; before that people talked about "wireless."

In the early days of wireless communication—the days of the spark transmitter—the greatest need was a sensitive, reliable *detector*. The function of the detector was that of rectifying the very weak, high frequency alternating currents induced in the receiving antenna by the electromagnetic waves.

A number of detectors had been developed. Marconi used a tiny glass tube of iron filings invented by Branley. This, the coherer as it was called, was not a rectifier but it served to detect the high frequency currents in a different way. When connected in series with a few dry cells and an electric bell or buzzer, such a tube of iron (and nickel) filings normally presents a high resistance to the flow of electricity and little or no current flows in the circuit. The instant high frequency currents are passed through such a tube some change takes place, the tiny particles of iron probably fuse (cohere) together, and the resistance of the tube is instantly lowered, permitting current from the battery to flow and thus operate the buzzer. Once the high resistance of the tube has been broken down in this way the condition remains even after the high frequency current has ceased to flow but the initial high resistance can be restored by shaking or tapping the tube. It was the practice therefore to arrange the buzzer clapper so that it would strike the tube as shown in Fig. 1. With this arrangement the coherer was always in a sensitive condition and the buzzer would continue to operate as long as the high frequency current persisted.

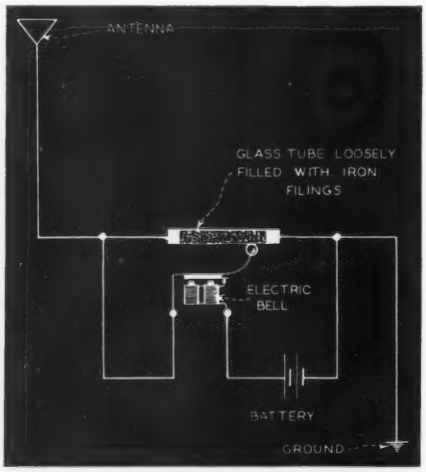


Fig. 1. The "Coherer" which Marconi first used as a detector was not a rectifier as were most later type detectors. High frequency currents from the antenna broke down the tube's high initial resistance and closed the circuit through the buzzer. Movement of the buzzer clapper, however, immediately restored the tube's high resistance

The coherer of course has nothing to do with electron tubes but it forms part of the history of detectors and it is therefore of interest here.

Other detectors used were purely rectifiers. A high frequency train of waves such as that shown in Fig. 2 for example could not actuate a telephone receiver or an ordinary electromagnetic instrument. In the first place the frequency (over 100,000 cycles per sec.) was so high that no mechanically moving diaphragm could respond to it, and secondly, the impedance of ordinary coil windings such as those necessary in telephone receivers was enormously high to such frequencies.[1]

By introducing a half wave rectifier into a high frequency circuit, a high frequency wave train such as that shown in Fig. 2 will have the negative portion suppressed, and a direct current such as shown in Fig. 3 will flow. This current will actuate a telephone receiver.

Various types of rectifiers were used in the early wireless receivers. Some of these were electrolytic cells, others used the unilateral conductivity of certain natural crystals, silicon, galena, etc.

[1]Impedance, $Z = \sqrt{R^2 + X^2}$, is a function of the frequency. In the above expression X^2 represents the total reactance, that is it is the combined inductive ($2\pi fL$) and capacitive ($\frac{1}{2\pi fC}$) reactance. Each of these latter expressions, it will be noted, contain the term f, frequency. Hence the impedance Z of any circuit is dependent upon the frequency of the current.

Applications

By A. W. KRAMER

Photo Courtesy Westinghouse

John Ambrose Fleming in England was the first to use a thermionic tube for this purpose. His tube was a simple diode. While this diode, known as the Fleming valve, was not noticeably more sensitive than other forms of detectors then in use, it had the distinct advantage of being much more stable in its operation and far less critical in its adjustment.

The next step was the introduction of a third element into the tube by De Forest as already explained. This was a notable advance, for the three element tube, as has been shown, is not only a rectifier but also an amplifier. It not only rectified the weak high frequency currents induced in the receiving antenna but it also amplified them. The De Forest "Audion" as it was called was, therefore, a much more sensitive detector than any theretofore developed. It was immediately adopted by many experimenters and its advantages over the older detectors were numerous. A typical circuit is shown in Fig. 4. The incoming signal currents are transferred to the receiver circuit by a coupling transformer T which is associated with a resonant circuit L C by means of which the circuit is "tuned" to the frequency of the incoming signals. The voltage developed across this resonant circuit is impressed across the grid cathode elements of the tube and combined rectification and amplification takes place in the manner described in earlier chapters.

Do not infer from this discussion that we are going to enter into a detailed study of radio, for that is not the case. These matters, however, lead up to the next fundamental property of the electron tube and they are of more than mere historical interest.

About 1912 we find a number of investigators using the De Forest Audion. As a detector it is a marvel but occasionally the circuits in which it is used have a tendency to "howl" or whistle. These squeals and whistles were regarded with annoyance at the time, even by De Forest himself, but they were important and subsequently these squeals were introduced in famous court proceedings regarding patent rights involving millions of dollars. Among the investigators was a young student at Columbia University by the name of Armstrong doing post graduate work in radio. One afternoon, so the story is told, he had a receiving circuit set up in the laboratory and was listening to the familiar signals known to every early radio man, amateur or commercial, of station WCC at South Wellfleet, Massachusetts. These signals were noted for their constancy and their unmistakable characteristic ring. On this particular afternoon they were steady as usual but as young Armstrong made some changes in the adjustment of the circuit, the signals suddenly began to increase in intensity to a degree far beyond anything he had ever heard or hoped to hear. Amazed, he carried the adjustment further and still the intensity of the signals increased and then with startling suddenness they became deafening and changed their character entirely. Instead of the clear, old familiar ring, they become mushy—hissing. Something very remarkable had happened and Armstrong began to study his circuit and labored at it all that summer. It was many weeks before he understood all that had happened in the circuit that afternoon but when he did, he was

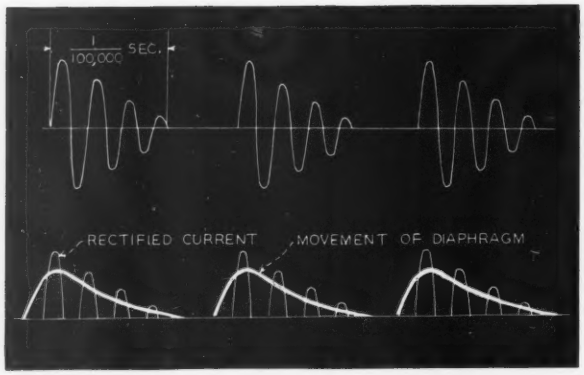


Fig. 2. (Above) High frequency wave trains in the antenna circuit as produced by early spark transmitters

Fig. 3. (Below) Effect of rectifying high frequency oscillation groups such as shown in Fig. 2. The frequency of the high frequency pulses is of course too high for the diaphragm of a telephone receiver to follow. The diaphragm therefore follows the average effect, shown by the heavy line

able to announce his famous principle of "regeneration." And for years the Armstrong regenerative circuit was used throughout the world.

Now what had happened? Simply this, since the three electrode tube is an amplifier, its output is greater than its input. This being the case, it is possible to take a portion of the output and feed it back into the input and somehow this action had occurred in Armstrong's circuit. Indeed, it had occurred in various other circuits, even before Armstrong's and it was no doubt responsible for the squeals and erratic behavior of some of the circuits but Armstrong was the first to recognize the phenomenon for what it was. This feed back action can be accomplished in various ways, by magnetic coupling, by electrostatic coupling or by combinations of electrostatic and magnetic means.

Suppose we consider the circuit in Fig. 5. This is practically the same circuit that is shown in Fig. 4 except that an inductance coil L_1 has been introduced into the plate circuit and arranged so that its magnetic field intersects the input coil L. Normally, alternating voltage from the antenna is fed into coil L. This voltage is amplified by the tube and appears in greater amplitude in the plate circuit. In Fig. 5, however, by means of the coil L_1 some of this *amplified* alternating voltage is fed back into the grid circuit, so that even if the external exciting source (the antenna) is removed, and provided enough energy is fed back, alternating voltage will still appear across both the grid and the plate circuits. By varying the degree of coupling between the two coils, L and L_1, more or less energy can be fed from the output back into the input. If enough energy is thus fed back, the circuit will continue to sustain electrical oscillations as long as direct potential is available from the plate battery. Only enough energy need be supplied by the battery to make up for the losses in the circuit.

Now, it becomes evident as to what happened to young Armstrong's circuit that afternoon at Columbia University. In adjusting the circuit constants he had effected a coupling between the output and input sides of the circuit and energy from the output circuit was added to that in the input circuit. This was again amplified and again fed back to the input side, and so on, the cycle was repeated, the signal growing stronger with each successive cycle. All this, of course, occurred in far less time than is required to tell about it. This was the now-familiar phenomenon of regeneration.

As long as the coupling between the input and output sides of the circuit was such that only a small amount of energy was fed back the only effect was to increase the strength of the current in the circuit. The effect of the "feed back" was only to neutralize part of the normal losses in the circuit.

Suppose, however, that the amplification is such that the amount of energy fed back is sufficient to make up for all the losses and still have some power left; then, this power will appear as self oscillations.

This is what happened in Armstrong's circuit. As the coupling was gradually increased there came a time when the "feed back" was sufficient to neutralize the

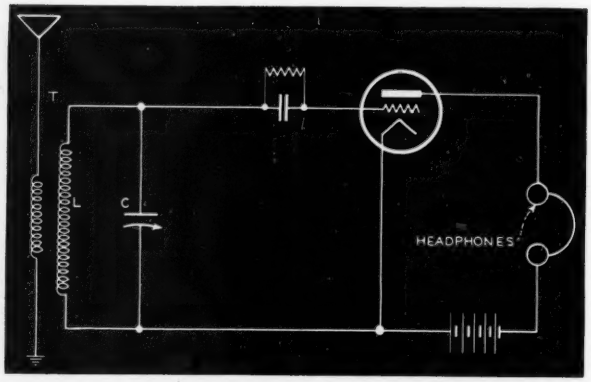


Fig. 4. Non regenerative electron tube detector circuit

losses in the circuit and the circuit began to "oscillate," that is, it became a generator of high frequency oscillations.

The signals from the antenna, however, were still being applied to the input side of the circuit. The frequency of these signal currents was not exactly the same as the frequency of the oscillations that were generated in the circuit since the frequency of the latter was determined by the circuit constants. Hence, these two frequencies interfered with each other and it was this interference or mixing of frequencies that

(Continued on page 635)

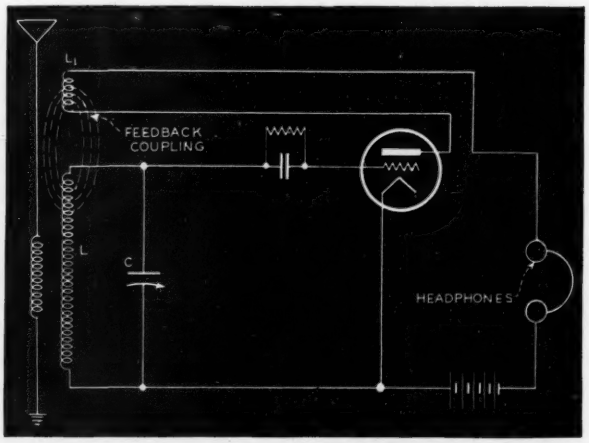
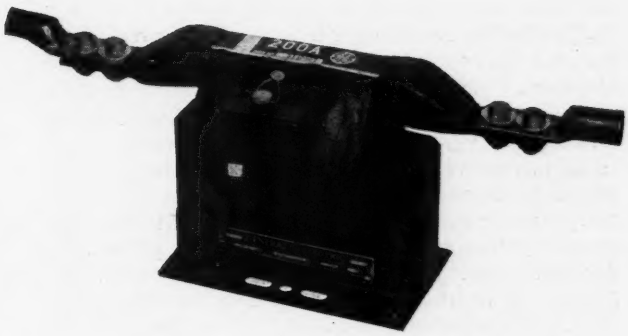


Fig. 5. The regenerative detector circuit



INSTRUMENT TRANSFORMERS

By E. S. TOWNSEND

Meter Dept. General Electric Co.
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IN PART I OF this discussion[1], the fundamental facts concerning the different types of instrument transformers and their uses were presented. With this as a background, the subjects of transformer burdens, errors, accuracy classifications, and ratings will now be considered.

Devices such as voltmeters, ammeters, etc., which are connected to the secondary of the instrument transformers are known as the secondary burden and are usually referred to as the burden on the transformer. Every meter or device that is connected to a transformer imposes a certain burden on the transformer. or in other words the transformer is required to supply a certain amount of power to operate this meter or device. In the same manner that a motor when overloaded will fail to carry the load so will an instrument transformer perform unsatisfactorily when it is overloaded. Transformers like motors are designed to carry definite loads and this rating of the transformer cannot be exceeded without difficulty. This burden imposed by the meters or instruments is usually expressed in volt-amperes. For example, a certain switchboard type ammeter imposes a burden on the current transformer of 5.4 volt-amperes, a certain type of watthour meter puts a burden on the current transformer of 1.3 volt-amperes and a burden on the potential transformer of 11.3 volt-amperes, etc. Thus, every device has a specific volt-ampere rating, and these ratings can be obtained from the manufacturer of the device. For all practical purposes to obtain the total burden on an instrument transformer, it is only necessary to add the volt-ampere ratings of the various connected devices. This system of calculation is subject to some error, because it neglects the power factor of the secondary burden, but unless laboratory accuracy is desired, the results obtained will be sufficiently accurate for ordinary commercial work. In making this calculation the length of the secondary leads should also be taken into consideration, as well as the size of the wire used in these leads since this will, in some cases, constitute a very appreciable burden on the transformer. For this reason it is desirable to locate the transformers, together with their meters and instruments, as close together as possible, thus reducing the burden of the leads to a minimum.

From the foregoing discussion it might be taken for granted that if a current or potential transformer were properly designed and constructed and not overloaded that its operation would be perfect, and that the relation of the secondary voltage or current to the primary voltage or current would be a very definite figure, with no possible variations. This is not the case, however, and all transformers have some errors in their operation. A discussion of these errors is beyond the scope of this article. A brief explanation only will be given as to what the errors are and how they affect the results obtained from the transformers.

Errors in instrument transformers are of two kinds: ratio errors and phase angle errors. A ratio error, as the name indicates, is an error in the ratio of the primary current or voltage to the secondary current or voltage. For example, if a transformer has a ratio of 20:1, as indicated by its nameplate marking, it will actually be exactly 20:1 only under certain conditions of operation. Under various other conditions the ratio will depart from 20:1 by some small amount, but in high quality transformers this departure from the

[1] Page 529 September issue.

nameplate ratio will be only a few tenths of one per cent, unless the transformer is very heavily overloaded, or required to operate under some other very abnormal condition.

In all alternating current work the phase relation between the various voltages and currents is as important as the values of the voltages and current themselves. Therefore a perfect transformer should receive energy to its primary winding and deliver it to the secondary burden without disturbing the phase relation of the voltages or currents. An instrument transformer can do this only under certain specific conditions, but when used over a range of conditions usually found in service, there is certain to be some error from this source. This phase angle error in a high quality instrument transformer will never amount to more than a few minutes if the transformer is operated under normal conditions.

Improvements in modern transformers, such as low-loss steel and compensating methods, have so reduced these errors that for all ordinary industrial and commercial work they can be ignored—their combined effect on the results obtained seldom being more than a fraction of one per cent. It is necessary, however, to take into account such possible errors when selecting transformers, and to see that the transformers and meters and instruments which they operate are selected so as not to cause excessive errors. It is much better to avoid errors than to attempt to correct them.

Accuracy Classification

Within the past few years the NEMA system of classifying instrument transformers in regard to their errors, or in regard to their accuracy, has come into general use by most instrument transformer manufacturers. An understanding of this classification system is essential to all who are concerned with the purchase, installation or maintenance of instrument transformers. As explained previously, all transformers have certain errors in their operation. While these errors are usually so small that they can be ignored under most commercial conditions, nevertheless a knowledge of the classification of these errors will assist in selecting the proper transformer for a certain installation.

Under the NEMA system three current transformer secondary burdens have been established and defined. These are, for convenience, designated as Burden X, Burden Y and Burden Z, and have the following values:

Burden X—2.5 volt-amp. at 90 per cent power factor
Burden Y—15 volt-amp. at 90 per cent power factor
Burden Z—50 volt-amp. at 50 per cent power factor.

These burdens have been selected not because they exactly equal any definite set of connected meters or instruments but because they represent three average conditions of loading a transformer. A 2.5 volt-amp. burden on a current transformer would be a very small burden, such as perhaps 1 watthour meter and a few feet of leads. A 15 volt-amp. burden would be an average burden, such as a watthour meter, an ammeter and a curve-drawing wattmeter. A 50 volt-amp. burden would represent a fairly large burden which might include—in addition to the devices mentioned above—a relay or some control device.

To go with the standard NEMA burdens just described, three classes of accuracy limits have been established. Known as Class ¼, Class ½, and Class 1, they define certain limits of permissible error—both for ratio and phase angles—as follows:

	Maximum Ratio Error		Maximum Phase-Angle Error	
	At 100% Current	At 10% Current	At 100% Current	At 10% Current
Class ¼	¼%	½%	10 min.	20 min.
Class ½	½%	1%	20 min.	40 min.
Class 1	1%	2%	40 min.	80 min.

With these burdens defined and accuracy limits established, it is now possible to rate any current transformer according to its characteristics. If with a burden equivalent to Burden X the transformer has characteristics within the limits established for Class ¼, the transformer is given a rating of ¼X. The same transformer with a burden equivalent to Burden Y might come outside the Class ¼ limits but within the limits of Class ½. Thus, the transformer would be given another rating of ½Y. Likewise, the same transformer might, with a burden equivalent to Burden Z, fall outside the limits of Class ¼ and Class ½, but come within the limits of Class 1, so that the same transformer would have a third rating of 1Z. The complete rating of the transformer would then be ¼X, ½Y, and 1Z.

A similar system of classification has also been established for potential transformers. Four burdens for potential transformers have been defined and designated as Burden W, Burden X, Burden Y, and Burden Z. These burdens have the following values:

Burden W—13 volt-amp. at 10% power factor
Burden X—25 volt-amp. at 70% power factor
Burden Y—75 volt-amp. at 85% power factor
Burden Z—200 volt-amp. at 85% power factor.

As was the case with current transformer burdens, these potential transformer burdens do not necessarily equal any exact combination of meters which might be connected to the transformer, but have been selected to cover the range from an average light burden to an average heavy burden.

Two potential transformer accuracy classes are defined, and referred to as Class ½ and Class 1. They apply from 10 per cent below to 10 per cent above rated voltage, and their limits are as follows:

	Maximum Ratio Error	Maximum Phase-Angle Error
Class ½	½%	20 min.
Class 1	1%	40 min.

If a potential transformer with a burden equivalent to Burden W comes within the limits of Class ½ it is given a rating of ½W. If with Burden X it comes within the limits of Class ½, it is given a rating of ½X, and so on. Hence, with Burdens Y and Z falling within Class 1, the complete rating of the potential transformer might be ½W, ½X, 1Y, and 1Z.

Most manufacturers of instrument transformers have adopted this system of classifying potential and current transformers and have published the NEMA classification of their transformers in their literature.

This NEMA system of classifying instrument transformer accuracy provides an easy means of determin-

ing the performance which can be expected from any installation. Transformers which are in service can be checked to determine if they are overburdened and new installations can be laid out to prevent errors and inaccuracies caused by overburdening. Obviously, when current and potential transformers are used to operate watthour meters on which revenue billing is to be based, the highest possible accuracy is desirable. On the other hand, if the transformers are operating indicating devices or control equipment, the highest accuracy may not be necessary and the transformers can be overburdened or transformers with a lower grade of accuracy selected.

For example a certain current transformer is advertised to have a NEMA classification of ¼X and ½Y. It has no Z rating since with Burden Z the ratio errors come outside the limits set by any of the NEMA classes. Assume now that this transformer is connected to a watthour meter which has a burden rating of 1.33 va. If the secondary leads are of short length, the burden which they impose on the transformer can be ignored for all practical purposes. Now assume that for some reason it is desired to install a recording ammeter on the same circuit. Assume that the recording ammeter imposes a burden of 18 va. on the current transformer. This burden, added to the burden of the watthour meter gives a total burden of 19.33 va. which is somewhat more than Burden Y. Under such conditions of operation the transformer would have characteristics outside Class ¼ and could not be recommended for the application. In this particular case the correct procedure would be either to install another transformer to operate only the recording ammeter or to put in a different type of current transformer which would have a rating suitable for operating both the watthour meter and the recording ammeter.

Causes of Serious Accidents

DURING the last 2 yr., companies having fatalities or permanent partial disabilities have been requested to make special reports to the National Safety Council on the circumstances involved in such injuries so that better information could be developed on the fundamental causes of serious accidents in the industry. Summary reports have listed 570 serious injuries during the last 2 yr. and 145 of these cases have been reported in detail. An analysis of the circumstances involved in them, according to the National Safety Council as published in a recent pamphlet, discloses:

1. Linemen were involved in more than one-half of all injuries. Of the numerous other occupations, supervisors and foremen figured in the most accidents, followed by repairmen and electricians, laborers, and groundmen.

2. Electrical apparatus, such as live conductors, transformers and switches, was the principal agency of injury, being involved in 79 cases. Working surfaces—poles and ladders particularly—figured in 26 serious injuries. Vehicles, elevators and hoisting apparatus, and hand tools were also frequently mentioned.

3. "Electric shock" was by far the most important type of accident, resulting in more than one-half of all serious injuries. Other important types were "falls of persons—one level to another," "falling, sliding, flying objects," and "caught in or between."

4. The principal mechanical cause assigned in almost one-third of the cases was "improper guarding." The lack of or lack of use of protective equipment by linemen working on or close to live conductors was often reported. A lineman with 13 yr. of experience, for example, was electrocuted because he did not wear rubber gloves while working on a job that was not considered hazardous but which was being done in close proximity to live conductors. Deaths also resulted from failure to use other rubber protection. A lineman of long experience wanted to do a job quickly, and, while he wore his rubber gloves, he did not use rubber protection on adjacent high tension lines; he accidentally contacted them and was electrocuted.

The next important mechanical cause was "hazardous arrangement." Several men lost their lives because they were not in the clear when a derrick, which was being tested, collapsed.

Defective substances or equipment figured in 17 serious injuries. A lineman, for example, was changing a dead-end insulator, the connector broke, and he was electrocuted.

5. Chance taking, disregard of instructions and other wrong attitudes on the part of employees were involved in 57 serious injuries.

Electron Tubes—

(Continued from page 632)

was responsible for the abrupt change in the character of the sound heard in the ear phones.

So much for the historical side. We have included it here not only because of its inherent interest but to show that the ability of electron tube circuits to "oscillate" is a consequence of the tubes' ability to amplify. Armstrong's original purpose was to amplify the signals. The fact that the circuit broke into oscillation was more or less accidental but it serves to show how easily such circuits can be made to oscillate. While the principle of oscillation is of tremendous importance in electron tube circuits for it forms the very basis of modern radio communication systems, at the same time it is very troublesome. Anybody who indulged in the almost universal indoor sport of kitchen-sink radio construction in the early twenties will recall the heartbreaking effects of oscillation. For the howls and squeals and wheezes of those home made radio sets were all manifestations of unwanted oscillations and despite all elaborate efforts to prevent them, they persisted. In the years since much has been learned about electron tubes and tube circuits and today the tube engineers and circuit designers know how to prevent oscillations when they are not wanted and also how to produce them efficiently where they are wanted. Indeed, as an efficient generator of electrical high frequency oscillations, the electron tube has displaced all other methods. Its range of frequency is enormous, extending from those of less than a cycle per second to those as high as a billion or more cycles per second.

Integral Feed Heating Turbine

By W. E. Caldwell
The New York Edison Co.

ADVANTAGES of superimposing high pressure units on older stations to modernize the plant and reduce operating costs are well known. There are problems involved in such installations which require treatment according to local needs. The low pressure units which will receive exhaust steam from the superimposed unit will operate at higher load and more hours per year than previously, due to shifting of load from less efficient units or plants on the system. This increase in load service and hours justifies improvements in the feed heating cycle of the low pressure station.

In the plants built from about 1905 to 1915 the initial pressure was generally about 200 lb. Some of the early plants were later revamped by the replacement of reciprocating engines by steam turbines and in some instances the earlier turbines were subsequently replaced by larger turbines. In general, the feedwater cycle was simple, the water being heated to about 210 deg. F. in open heaters by exhaust steam from steam-driven auxiliaries. At light loads an excess of auxiliary exhaust steam existed and at heavy loads a deficiency, but under average conditions the demand and supply of exhaust steam was reasonably well balanced. Due to the moderate pressure, deaeration was not an important consideration.

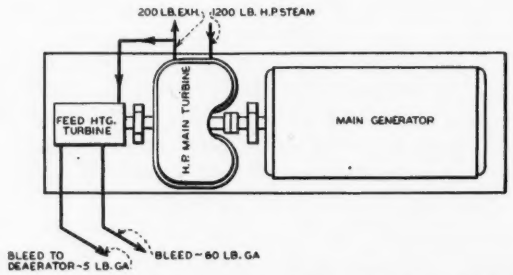
Old Turbines Not Adapted to Change

In a few of the larger of these older plants relatively modern units of large capacity replaced the prime movers during later years. Some of these turbines had capacities as high as 35,000 kw. and were provided with one or two extraction openings. It was thought at the time that these extraction openings could be utilized for bleeding, when and if, warranted by plant changes or economic justification.

With the superposition of high pressure units complete deaeration of the feedwater is necessary and also an additional bleed stage between atmospheric pressure and 200 lb. becomes attractive. The extraction openings on the older turbines do not usually meet the requirements well for a number of reasons, among which might be mentioned that the internal parts of the machines are seldom of sufficient strength to permit extraction of the quantities desired; the extraction openings are usually from stages in which the pressures are not well suited to the requirements, from an efficiency standpoint; and lastly, the physical size and location of the low pressure machines generally result in a rather complicated layout and operating procedure to bleed from these units. This is also influenced by the fact that a number of low pressure units usually share the exhaust steam from the high pressure unit.

In the substitution of high pressure motor-driven boiler feed pumps for the steam-driven feed pumps of the earlier installation there is a reduction in the quantity of exhaust steam for feed heating purposes. With an increase in condensate from the low pressure turbine, and reduction in exhaust steam from the auxiliaries, the condensate temperature from the low pressure units is substantially reduced. It, therefore, becomes desirable to heat this up to 212 deg. F. or above, for the purpose of improving economy and deaeration.

To accomplish this, past practice suggests the use of a small feed heating turbine receiving steam at 200 lb. pressure from the exhaust of the high pressure unit, driving its own generator in parallel with the main unit and exhausting to a deaerating heater at 5 lb. back pressure. Economic studies dictate including in this heating turbine an extraction opening around the 60 lb. point at full load. Governor control of the output of this unit would be so regulated as to maintain constantly the required back pressure in the deaerating heater.



The use of a feed heating turbine on the same shaft as the main turbine offers many advantages when modernizing an old plant where bleed steam is not available for feed heating

Such a unit would necessitate additional switch positions in the electrical galleries, which together with added installation costs, render it desirable to eliminate the small generator. As an alternative, this feed heating turbine might be incorporated in the shell of the high pressure turbine beyond the exhaust opening. Due to structural and other limitations, this is not usually desirable, so the feed heating turbine seems most attractive as a separate unit but connected to the shaft of the main turbine so that its output may be transmitted to the main generator. The admission of steam to this turbine may be regulated by the needs of the deaerating heater in which a constant pressure of about 5 lb. gage is required.

This simply requires a steam admission valve on the extraction turbine actuated by the pressure in the deaerating heater. The steam flow at the 60 lb. extraction opening will be self-regulating and the quantity will be established by the heat which can be absorbed

by the water passing through the heater. The boiler feed pumps may be located below and adjacent to the deaerating heater, from which they will take their suction. Such a turbine in the average station would require at full load about 10 per cent of the exhaust steam from the high pressure unit and would develop about 8 per cent of the total input to the high pressure generator.

The feed heating turbine permits a compact arrangement in the location of the high pressure unit, pumps and deaerator, which simplifies the control, from the standpoint of supervision and operating convenience. It may possess some advantage, also, in starting the main turbine, due to the increased expansion range.

Full Automatic Diesel Pumping Plant

FULL AUTOMATIC DIESEL engine pumping station operation for municipal water service at North Easton, Mass., has been so successful that a second unit will be installed in the same plant in the near future. Placed in commission last December, the equipment in this short period of time has demonstrated effectively the possibilities of isolated municipal stations of this design for continuous daily service and operating economy. In addition the unit is furnishing heat to maintain the pumping station at a normal 70 deg. temperature, the cooling water from the Diesel engine being utilized for such purpose at no additional fuel cost.

The installation, known as a Tecomatic Diesel electric power plant, consists of a fully automatic, multiple, standardized unit, designed and installed by the Thermal Engineering Co. It is composed of a 100-hp., six-cylinder, four-cycle Hercules Diesel engine, direct-connected to a single-stage Aldrich centrifugal pump, both mounted on common cast iron base and requiring minimum floor space. The unit operates at a speed of 140 r.p.m., and has a rated capacity for delivering 800 to 1000 g.p.m., against a total operating head of 170 ft. The second Diesel pumping unit soon to be installed, as stated, will replace the present electric power standby equipment at the plant, of which Leon French, superintendent of the water department at North Easton, is in charge.

Economy of Diesel equipment, is leading to the installation of such units for industrial service. Two of these are now under way in plants in Massachusetts, one to be of straight Diesel-electric type and the other a balanced steam and Diesel-electric generating plant. The latter will be composed of a 100-kw., double-ended electric alternator, propelled by two 80-hp., Diesel engines operating in parallel, with a single 250-kw. steam engine-driven alternator. The power input of the Diesel units will be controlled by the exhaust pressure of the steam engine, so that the demand for steam for processing service at the factory will be balanced by the power requirements. The operation of the equipment will be fully automatic.

New Structural Steel Specifications

A NEW STANDARD Specification for the design, fabrication and erection of structural steel for buildings has just been issued by the American Institute of Steel Construction. In this new Specification revisions have been incorporated in accordance with the recommendations of a Committee on Specifications.

Among the important changes in the Standard Specification are allowable unit stresses which accord, in general, with a basic stress of 20,000 instead of 18,000 lb. per sq. in. in tension.

With a view to conservatism, the first Specification of the American Institute of Steel Construction issued in 1925 prescribed a basic unit stress of 18,000 lb. At that time the minimum yield point of standard structural steel was 30,000 lb. per sq. in. Since that time several changes have occurred that affect the situation:

1. The minimum yield point of the present day standard structural steel has been raised to 33,000 lb. per sq. in., with an increase in the ultimate strength from 55,000/65,000 lb. to 60,000/72,000 lb.

2. The principal foreign countries of the world have increased the allowable basic unit stress permitted for comparable steel to approximately 20,000 lb.

3. Knowledge has been highly developed and current practice has been standardized in the structural steel industry, with a consequent increase in the dependability of structural steel to meet given conditions of use.

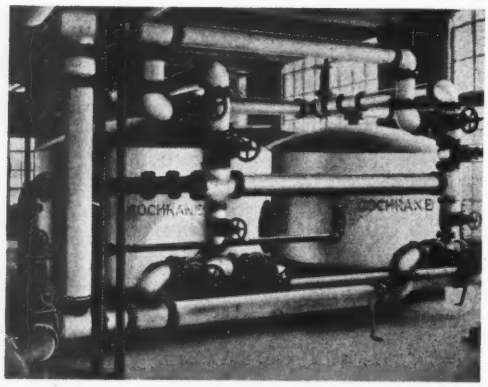
In 1934 the Institute authorized its Committee on Specifications to consider the advisability of increasing the basic unit stress. After a careful canvass of the situation the Committee decided to recommend the use of 20,000 lb. per sq. in. basic stress coupled, however, with more rigid requirements of design and fabrication, and these requirements have now been incorporated in the revised Specification. The Committee believes the net result will prove not only to be economical and at the same time entirely safe, but to result in a more scientific use of structural steel.

Sections rewritten relate to bearing pressure on rivets, design of plate girders, and web crippling of beams.

To the industry the Institute is making a free distribution of the new Specification but duplicate copies may be had only upon payment of the cost of production. Those desiring copies of the new Specification in quantity may obtain same in lots of 10 to 50 at 15c each, in lots 50 to 100 at 10c each and in lots of over 100 at 8c each.

STEEL MAKING uses 1.41 t. of coal for each ton of steel produced. Heavy orders during the last month brought steel ingot output to 75½ per cent and it is estimated the 1936 figures will be about 85 per cent of the 1929 figures.

New Developments in the



This is the second of two articles on the subject of Feedwater treatment by the author. The first, dealing with the fundamental principles of Feedwater treatment appeared in the October issue. In this article the newer developments in the art are considered.

By CHARLES E. JOOS
Manager, Water Treatment Division
Cochrane Corporation

FEWER DEVELOPMENTS in feedwater treatment have to do with greater efficiency where both softening and deaeration are desirable. For the deaeration of high carbonate waters, tray heaters are unsuitable because of rapid deposition of solids, which naturally interferes with the deaeration process. With corrosive water, tray corrosion necessitates the annual removal of these trays for cleaning and replacement which is a large maintenance item. To overcome part of this objection it has been necessary to have the deaerating heater follow the water softener, making a rather expensive installation. In the newer development a method of deaeration that is not affected by the precipitated hardness is built into the softening equipment itself.

The deaerating hot process softener shown in Fig. 1 has been applied successfully in over a score of low and high pressure boiler plants. The method of deaeration is unique in that trays are absent, the removal of the last traces of oxygen being accomplished by means of a high velocity steam jet or atomizer. The preheated water falling on this high velocity jet is thoroughly dispersed or atomized, exposing the maximum of water surface, so that the oxygen escapes easily. The raw water first enters the softener through the regulating valve and the vent condenser and is then preheated in the jet heater, following which the chemical reagents are added and the hardness precipitated. The softened and settled water then passes to the atomizing chamber, wherein it spills over the lip of the atomizer onto a jet of steam. The water is heated and atomized so completely that all tests so far made on this type of deaerator have indicated zero oxygen by the Winkler test. The energy available in the steam jet for dispersion of the water is enormous and with a drop in pressure of only ½ lb. across the opening of the atomizer, the energy expended is comparable to spraying water through a nozzle under a pressure of approximately 200 lb. per sq. in.

This method of deaeration has been applied to large open heaters and one of a capacity of 640,000 lb. per hour is now in successful operation at the Congress Street Heating Plant of The Detroit Edison Co. The jet type of deaerator was selected at this plant so that heater trays could be eliminated and possibly to break up some of the bicarbonates, reducing the amount of free CO_2 in the steam condensing apparatus. By employing the jet principle, trays and other complications within the heater shell are eliminated. The apparatus operates very successfully in removing oxygen and free carbon dioxide from the water even when operated at rates far in excess of its rated capacity.

Sodium Sulphite

Sodium sulphite is sometimes used as a chemical addition for the fixation of oxygen to prevent corrosion and there is no question but that this chemical has a field, especially where older deaerating equipments have not afforded complete protection. The use of sodium sulphite as a substitute for deaeration is not, however, considered good practice where new equipment is to be purchased. Comparison of the use of an open heater plus sodium sulphite with the more costly deaerating heater will show that the latter is to be preferred by reason of the higher efficiency of the apparatus, the elimination of expense for chemical, and the elimination of chemical dosing apparatus and the attention which it demands. The calculation given below shows that deaerating equipment would pay, even though for capacity assumed a deaerator costs approximately $800.00 more than does an open heater. The amount of anhydrous sodium sulphite that has been recommended for the fixation of various quantities of oxygen is as follows:

Ml. Oxygen per liter	Sodium Sulphite per 1,000,000 lb. water
0.01	0.167
0.05	0.836
0.10	2.506
0.15	3.340
0.20	4.176
0.25	5.012
0.30	5.846
0.35	6.680
0.40	7.516
0.45	8.360

Let us assume the following conditions:

Capacity .....100,000 lb. per hr.
Yearly hours of operation.....6,000
Oxygen from open heater.....0.30 ml. per liter
Cost of sodium sulphite.....5c per lb.
Heat value of coal.....13,000 b.t.u. per lb.
Coal cost .....$4.00 per ton
Boiler efficiency 85%
Terminal difference in standard open heater....3 deg.

Yearly cost of sulphite

$$\frac{100{,}000 \times 6000 \times 5.012 \times 0.05}{1{,}000{,}000} = \$150.00$$

Yearly cost of fuel due to greater terminal difference with standard heater

$$\frac{3 \times 100{,}000 \times 6000 \times 4}{13{,}000 \times 0.85 \times 2000} = \$328.00$$

Total cost of operation when using sulphite $478.00

Operation of boilers at extremely high ratings has forced upon boiler designers the problem of overcoming foaming and priming or carry over, and in some cases boiler manufacturers advocate the use of independent steam purifiers or steam washers. A typical example of a steam purifier installation is shown in Fig. 2. External devices are now generally regarded as necessary for complete protection, as extreme variations in water level within the drums are likely to occur with rapid variations in load, handicapping internal devices when good performance is most needed. Purifiers of this and other designs have enabled boiler manufacturers to operate at higher ratings than would otherwise have been possible. In one plant with which the writer is familiar, a steam purifier of the type shown serves also as a continuous automatic blow-down. This is not hand controlled, but the boilers are allowed to prime into the steam purifier, where the moisture is stripped from the steam and directed to a high capacity trap by which it is discharged into a long length of 30 in. exhaust main, while the unflashed water passes through a heat exchanger and delivers its heat to the incoming makeup water. This system has worked out very satisfactorily, although a continuous blow-off equipment which will maintain such concentration in the boiler as to avoid serious carry over is to be preferred, with purifying equipment provided to strip the steam only of the small amount of moisture carried over mechanically. Continuous blow-down equipment has become very popular, not only for the better control of concentration, but for the economies effected as well.

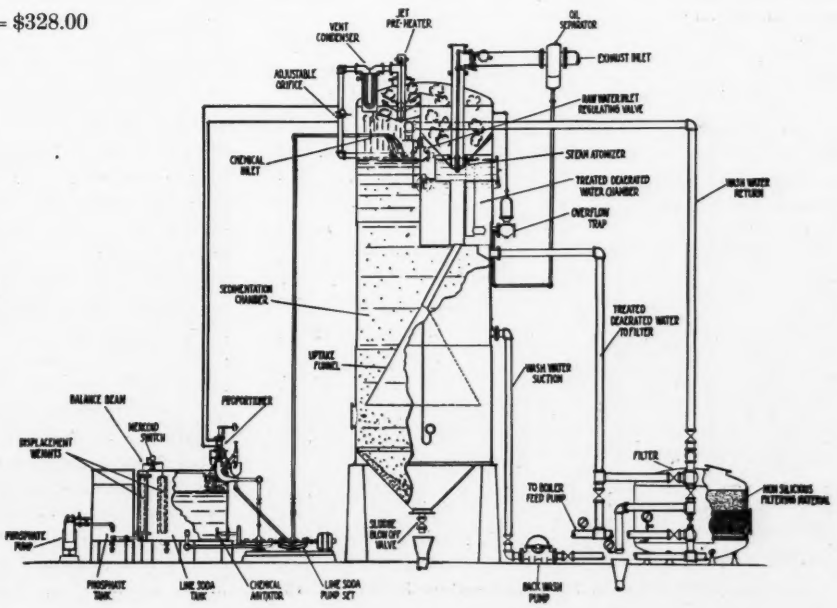


Fig. 1. Typical deaerating hot process softener used successfully in many high and low pressure boiler plants

External Softening by Phosphate

A new system of feedwater treatment in which tri-sodium phosphate is used as the chemical treating

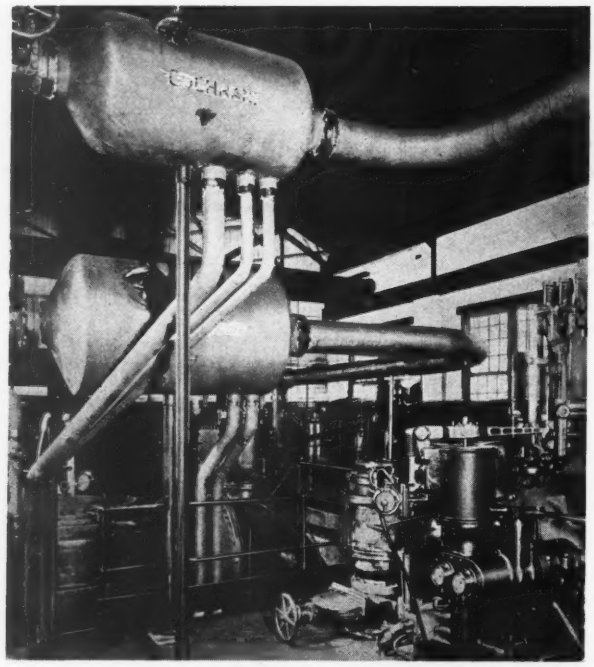


Fig. 2. An example of a steam purifier installation in a turbine room

agent in a hot process softener instead of lime and soda ash has been developed for low hardness waters.* With the tri-sodium phosphate as the reagent, the precipitation of the hardness is so complete that what is commercially designated "zero hardness" water is obtained. Table I gives the analyses of the raw water and of the corresponding treated water taken from a system of this kind.

TABLE I

Analyses of raw and treated waters showing effectiveness of primary treatment by phosphate

Substance	(Parts per Million) Raw	Treated
Calcium carbonate	9	3
Calcium sulphate	15	—
Magnesium carbonate	1	1
Magnesium chloride	3	—
Silica	2	3
Iron oxide and alumina	—	—
Sodium chloride	1	5
Sodium carbonate	—	10
Sodium sulphate	—	16
Sodium phosphate (tri)	—	16
Sodium phosphate	—	16
Volatile and organic	37	11
Total solids	68	81
Suspended matter	Fine—White	Trace
Carbon dixoide	2	—
pH	6.3	8.7

It will be seen that the hardness is reduced to an extremely low value, far lower than could be obtained by lime and soda ash. This method, which was originated five years ago and is gaining in popularity, has found application in a number of high pressure plants.

If a cold process softener is already in use, the hot process softener can be added to give phosphate treatment to the water, which has been softened in the cold process by lime and soda ash. Fig. 3 illustrates this system of feedwater treatment as used for the preparation of 100% makeup water for the 800 lb. boilers of the Rochester Gas & Electric Company. Because of the cost of the reagent, this treatment cannot be economically applied to hard waters, but it can be used as an adjunct to either a cold or a hot process softener in which the hardness is reduced to low values by use of the much cheaper reagents lime and soda ash. This method is a step in advance of the lime-soda supplementary phosphate treatment in that the precipitation of the remanent hardness is brought about outside the boiler and the effluent from such a system is ideally suited to even the highest pressure that may be considered.

*"Primary Treatment by Phosphate"—C. E. Joos, Power Plant Engineering, April, 1936.

Conclusion

A sharp distinction should be made between the terms "water softening" and "water conditioning" in the selection of equipment and processes. The selection of water treating equipment is rational only when the effluent is "balanced". Each water supply should be studied separately, taking into account its chemical and physical conditions as well as the equipment in which the water is to be the working fluid. To the designer of power plants confronted with the desire, and more often the necessity, of keeping initial and upkeep expenditures at a minimum, this may not be an easy task. Advice from manufacturing specialists in this field, based on experience, is fortunately available, and guidance by them will prove invaluable to the power plant designer and operator.

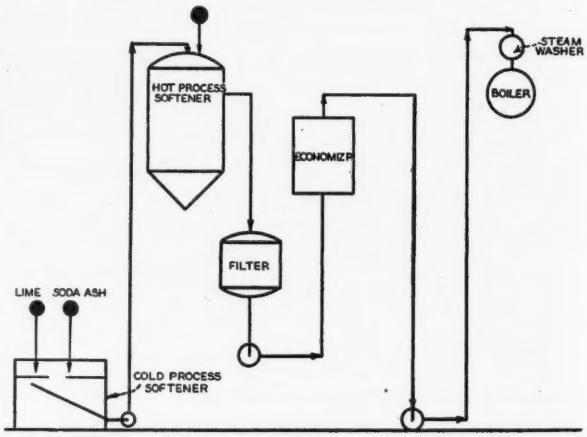


Fig. 3. System of feedwater treatment used for the preparation of 100 per cent makeup for the 800 lb. pressure boilers of the Rochester Gas and Electric Co.

Elihu Thomson, one of America's greatest pioneers in the field of electrical science and holder of more than 800 patents, was honored Friday night, Oct. 16, when the Detroit section of the American Welding Society dedicated its program to the fiftieth anniversary of one of Professor Thomson's greatest inventions, that of resistance welding. The basic patent on this method of joining metals by putting them in contact with one another and then passing through them an electric current which fuses and unites the pieces was granted in 1886. The anniversary program was presented in the Detroit Edison auditorium.

Michigan Carton Co. Adds High Pressure Boiler

New Plant at Battle Creek Paper Mill an Excellent Example of Foresight

TOO MANY industrial power plants are built without sufficient attention being paid to future load requirements. This is a difficult problem, for not only must expansion of the company be considered but the changing trends of industrial practice and power plant design must not be overlooked. Recent experience has shown that industrial plant electric loads have increased much faster than expected and boiler pressures of 400, 600 and 800 lb. can no longer be considered as belonging exclusively in the central station field.

The industrial engineer must, therefore, design his plant with the utmost flexibility in order to meet any combination of unforeseen circumstances that may arise. The new boiler plant of the Michigan Carton Co. at Battle Creek, Mich., is noteworthy in this respect. Hemmed in on one side by the paper mill, on the other by a permanent coal storage and on the other two sides by an old boiler plant operating at full capacity, the available space measured but 30 by 38 ft. Walls and existing equipment were moved to increase this space to 36 by 51 without interfering with operation of the old plant. In this space was slipped, literally by means of a "shoe horn and talcum powder," a 100,000 lb. per hr., 300 lb. Springfield boiler and accessories.

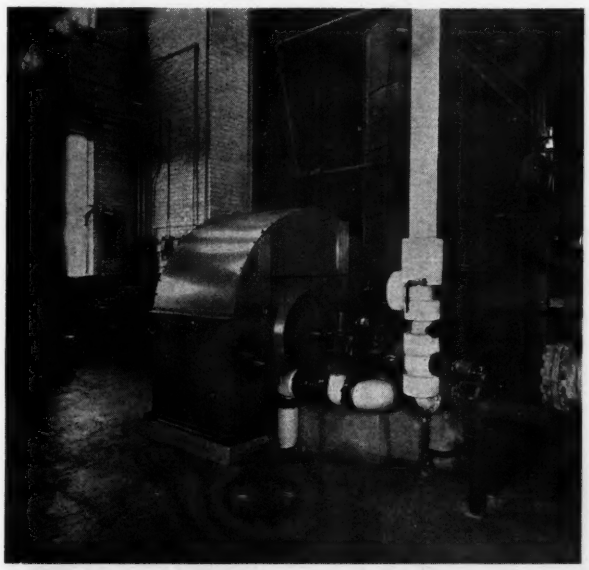


Fig. 1. Turbine driven forced draft fan located directly in front of the new boiler. The proximity of the old vertical boilers and steam header in the background indicate the limited space available for the new boiler plant

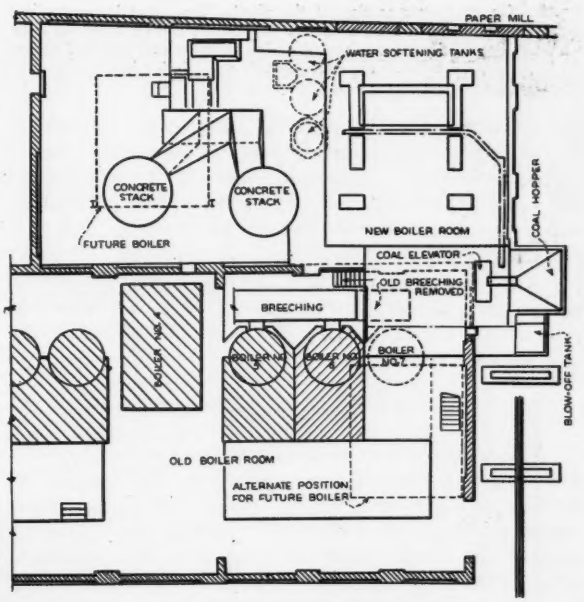


Fig. 2. New boiler plant now hemmed in on four sides will be free to expand in either direction as soon as old boilers and stacks are removed. The next unit may be located either in front of, or at the left of, the new boiler leaving the alternate free for new high pressure turbines should future conditions warrant this step

This in itself was a creditable accomplishment, yet the chief interest in the plant is the provision made to meet future needs. The boiler, now operated at 150 lb. saturated in parallel with the old vertical boilers, is designed for 300 lb. pressure and provision made for

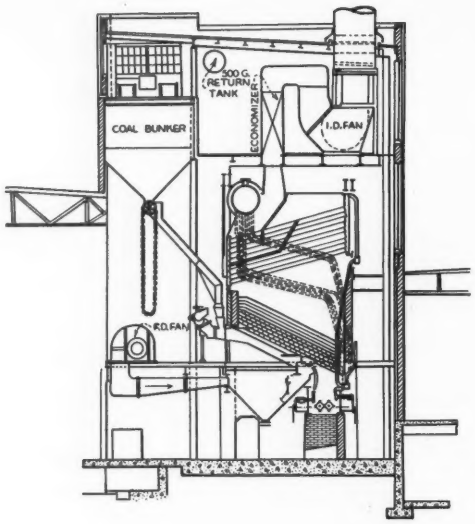


Fig. 3. General cross section of the plant. The separate economizer and induced draft fan are on the top level. The forced draft fan is on the firing floor. Square corner ducts with turning vanes are used to decrease the space requirements and friction loss

the addition of a 100 deg. F. superheater in case an undue increase in electrical load makes a new turbine plant advisable. In addition, removal of the old boilers and stacks will allow expansion in two directions, either to the front or side of the new boiler. The coal handling equipment will serve either way. Present plans call for an extension of the boiler plant, as shown at the left of the plan drawing, where the two old stacks now stand, leaving the space in front of the new unit for a new turbine room.

Water Walls

As shown by the general cross section, the boiler is a Springfield cross drum type with 8710 sq. ft. of heating surface less water walls, baffled for three passes and fired by a 8 retort, turbine driven, Taylor stoker. The entire rear wall and both side walls are water cooled by Springfield Boiler Co. water walls, the first six rows of the latter being covered with cast iron blocks, the top two rows bare. The clinker grinders, driven by 2-2 hp., 440 v. Louis Allis motors, discharge to an ash hopper which is emptied manually by means of a hoe and shovel into a United steam jet ash conveyor which discharges to a 65 t. track hopper.

Forced draft is supplied by a 44,300 c.f.m. at 7 in. H_2O, Clarage Type FD fan located on the firing floor immediately in front of the stoker and driven by a 73 hp., 150 lb. Elliott turbine through reduction gears. To conserve space and reduce friction losses the forced draft duct has a square corner and turning vanes as shown in the drawing.

Separate Economizer

On the top floor and immediately above the boiler outlet damper is a 3780 sq. ft. Foster Wheeler economizer. Gases from the economizer go directly to the induced draft fan and are discharged from a 50 ft. steel stack supported on the building steelwork. This fan is a Clarage Type RT rated at 81,800 c.f.m. at 6 in. H_2O and driven by a 129 hp. 150 lb. Elliott geared turbine with both damper and speed control.

Bailey air operated combustion control is used and installed with a master panel so that additional boiler units may be added to the same system. The Bailey boiler control panel has a steam pressure gage, a multipointer draft gage, feedwater pressure recording gage, four pen recorders for economizer gas and water, boiler meter and four transfer valves to shift from automatic to manual control. The forced and induced draft fans and dampers may be individually controlled.

Other boiler equipment consists of Diamond soot blowers, Edward stop, check and blowoff valves, a Republic CO_2 meter, Bailey feedwater control with Edward valves, a No. 12 N. Hagan steam separator with a No. 3 Nicholson trap, Reliance gage column, Lunkenheimer steel valves, Limbert piping, Elliott non-return valves and Crosby safety valves.

Coal Storage

An outside 3500 t. coal storage is served by a Harnischfeger gantry crane which discharges to hopper just outside the new plant. From this hopper coal is elevated to a 120 t. overhead bunker by a 40 t. per hr. Stephens-Adamson handling system consisting of a belt feeder and bucket elevator. From the bunker coal is delivered to the stoker hopper by a Stock Conical coal spout.

This plant was designed by Robert G. Bohn, mechanical engineer of the Michigan Carton Co., with the architectural details and drafting done by Shreve, Anderson & Walker of Detroit. Clyde L. Johnson is chief engineer of the power plant.

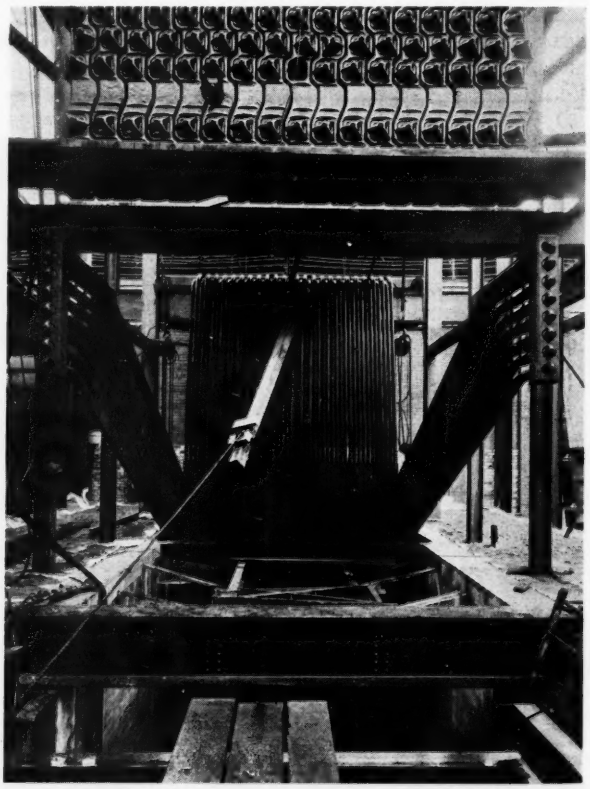


Fig. 4. Unusual construction view shows the arrangement of the water walls on both back and sides to advantage

Seals against Fluid Pressure

Part VI. Types of flange faces used on power plant piping and physical requirements of gasket materials

FAILURE of a flanged pipe joint to prevent the escape of the fluid within it may in many cases be traced directly to the design of the flange. It is not intended, however, to take up the entire problem of flange design in this series of articles but to confine the treatment of seals to those surfaces, joints or grooves where leaking may actually occur. So in this article only the flange faces will be considered and their relation to the gaskets used to seal the joint. In another article of this series metal to metal joints such as those between the flange and the pipe end will be given full consideration.

Flange faces are designed with the idea that they shall be as simple to manufacture and install as possible. These flanges are bolted together and one of the difficult problems in the design is to secure the necessary pressure between the flanges to ensure a leakless joint without increasing the flange diameter to an inconvenient size and to provide the necessary gasket space to prevent the destruction of the elastic qualities of the gasket.

Straight plain faced flanges are smooth over the entire face and are commonly used on water and steam lines carrying pressures not to exceed 125 lb. pressure. The form of gasket used with these flanges may be either full face with holes cut for the bolts or the ring form which fits inside the ring of bolts. The full face gasket is not so easy to cut but will stay definitely in its place while being installed. The ring gasket, however, gives very good results if of proper thickness and carefully installed to make certain that it is concentric with the bore of the pipe and does not interfere with the flow of the fluid through the pipe.

To give greater strength to the gasket material, thus providing for higher pressure, the serrated plain face flange has been made by cutting concentric curves with a round nose tool. The object being of course to prevent the gasket from blowing out. They have been considered desirable only when extra thick gaskets are required but, with stronger gasket material available, this form of flange face is seldom desirable.

A modification of the serrated plain face flange is that on which a diamond pointed tool is used to score concentric rings on the face. It was devised for use with lead gaskets sometimes used on oil and acid lines. Reasonable pressure on the flange bolts squeezes the

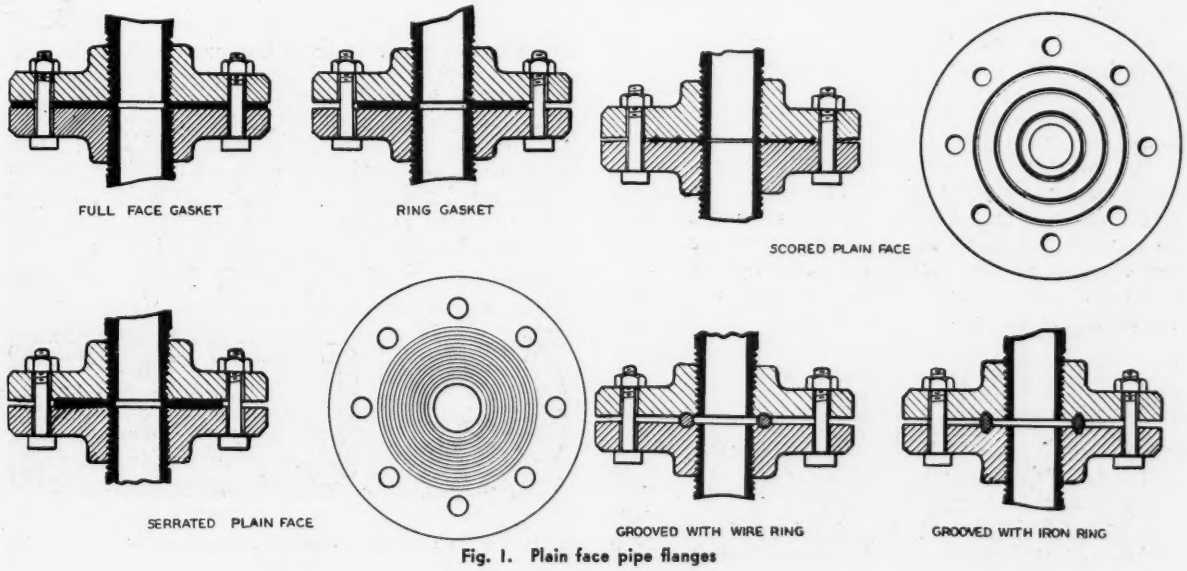


Fig. 1. Plain face pipe flanges

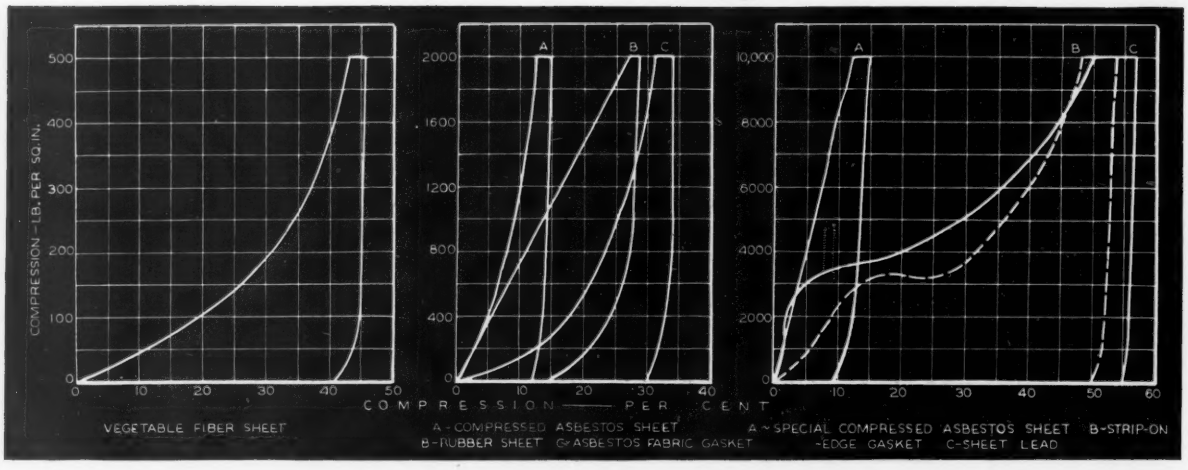

COMPRESSION - LB. PER SQ. IN.
COMPRESSION —— PER CENT
VEGETABLE FIBER SHEET
A - COMPRESSED ASBESTOS SHEET
B - RUBBER SHEET C - ASBESTOS FABRIC GASKET
A - SPECIAL COMPRESSED ASBESTOS SHEET B - STRIP-ON EDGE GASKET C - SHEET LEAD

Fig. 4. Load compression curves for gasket materials

lead into the scores and thus prevents blowing out and leaks.

Grooved plain face flanges have a single groove cut in the face of the flange. The seal is made by means of a copper or lead wire, or sometimes a specially designed iron ring pressed into the grooves by the pressure on the bolts. Such a joint has little if any elasticity and when installing the piping or opening the joint requires considerable longitudinal movement of the pipe.

Flange Faces with Matched Surfaces

For pressures above 125 lb., common practice is to use a flange with a raised face to which a gasket of the ring type is fitted. This raised face is about 1/16 in. above the rest of the flange and extends from the bore to a circle a short distance inside the bolt holes. It has the advantage that high compression pressure can be brought to bear on the gasket and, due to the opening between the flanges at the bolt circle, there is no danger of the edges of the flanges coming together and preventing proper pressure being applied to the gasket. In the early use of superheated steam it was discovered that gaskets of organic matter would carbonize if they came in contact with the steam so for this service the raised faces of the flanges were ground, so as to give a metal to metal joint. With modern gaskets, however, such expensive machine work is not considered practical.

Tongue and groove flanges are available for fluid pressures as high as 800 lb. The idea behind this design is that packing placed in the groove cannot be blown out and has only slight contact with the contained fluid. To install the piping or break a joint with this type of flange, longitudinal movement is necessary, an advantage, however, is that rod packing made up into the form of grommets can be used instead of gaskets. This type of flange face is commonly used on ammonia piping.

The male and female flange joint is formed of one flange with a raised area on the face while the companion flange has a matched depressed area on the face. The gasket fits into this depressed area and is held from blowing out not only by the friction between the flanges and the strength of the gasket but the outer wall of the depression. They are used quite extensively on hydraulic piping, and to some extent for steam, for pressures as high as 800 lb.

To overcome some of the objections to earlier forms of joints, the Van Stone joint was devised. To make these joints the flange, made without threads, is slipped over the end of the pipe which it fits loosely. The end of the pipe is then expanded into a flange and the surface faced where the gasket is placed. The ring flanges clamp the pipe ends together, compressing the gasket by means of flange bolts. This type of joint is used extensively on steam piping and has the advantage that the joints can be opened readily without springing the line apart and the flange bolt holes are easily matched.

For high pressures and temperatures, a suitable type of joint is the Midwest which is a modification of the Van Stone, the principal difference being that the contact surfaces are ground to spherical form to make a metal to metal joint in which a gasket is not required.

In the Sarlun joint, the Van Stone principle of construction is employed but instead of using a gasket the sealing is done by welding together V-shaped lips provided around the edges of the flange.

Purpose of Gaskets

Piping is by no means the only place around the power plant where fixed joints must be sealed against fluid pressure but the principles involved are substantially the same. Two solid parts of a fluid container are so fitted together that their contacting surfaces are continuous and are so clamped together that no leaks are permitted. To accomplish this either a ground metal to metal joint or some form of gasket material

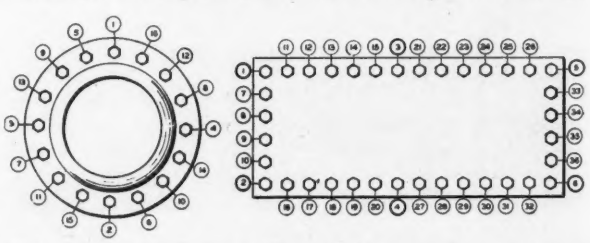


Fig. 3. Correct order for preliminary taking up on flange and cover plate bolts

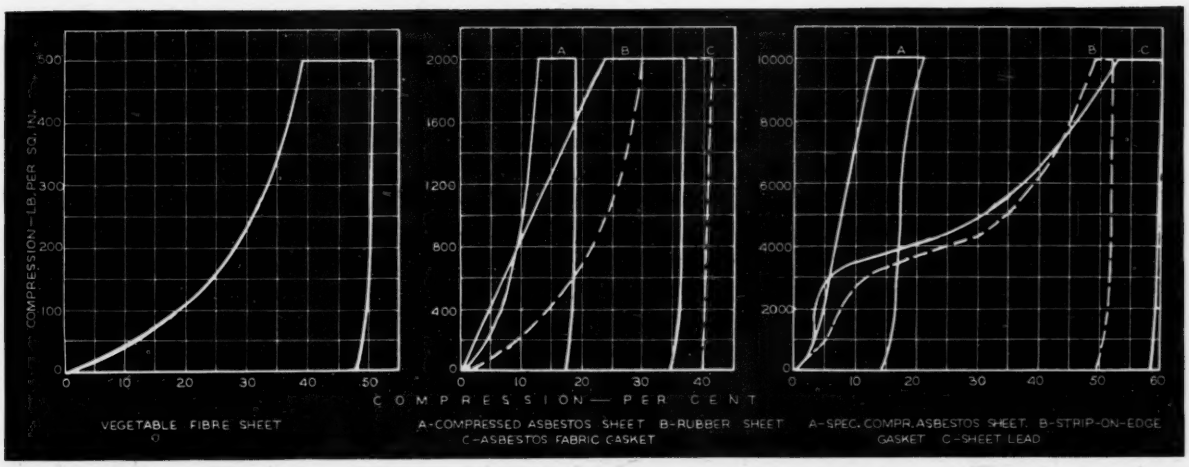

COMPRESSION—LB. PER SQ. IN.
COMPRESSION—PER CENT
VEGETABLE FIBRE SHEET
A-COMPRESSED ASBESTOS SHEET B-RUBBER SHEET C-ASBESTOS FABRIC GASKET
A-SPEC. COMPR. ASBESTOS SHEET. B-STRIP-ON-EDGE GASKET C-SHEET LEAD

Fig. 5. Load compression curves for disks of gasket materials held between heated platens

which is sufficiently plastic to fill the uneven spaces in the contacting surfaces must be provided. Wherever the contacting surfaces are circular, piping practices may be adopted. Where irregular shapes are encountered, however, precaution is necessary to secure a well fitted gasket of material suitable in physical and chemical characteristics for the service and to make certain that the pressure on the gasket is evenly applied, as a major portion of difficulties with seals is failure to apply even pressure.

Hand-hole, man-hole and cover plates of all types are subject to considerable distortion if they are not properly adjusted in position and if the bolts are insufficient in number, improperly placed or have not been evenly drawn up. In maintenance work extreme care must be taken in handling the plates to prevent injury to the contacting surfaces and to keep these surfaces clean and smooth. Where the joint is subjected to severe service, it is seldom advisable to replace a soft or fibrous gasket for use a second time, metallic cased gaskets, however, may be reused a number of times if upon examination they show no destructive injury.

What Squeeze Does to Gasket

Just what happens to gasket material when put into service is well worth considering. Assume, for example, that the gasket is properly cut or chosen from stock for the joint, that the faces of the joint and the gasket are clean and smooth, that the gasket is properly placed in the joint and the holding bolts are evenly drawn up to give only moderate pressure on the gasket. So far no physical changes have taken place in the gasket, its thickness has not been reduced, it has not been forced to change its form so as to fill the low places in the flange face, it has not as yet been subjected to heat nor the go and come strains encountered during service, but the gasket is not ready to retain fluid under pressure.

Now comes taking up on the bolts, this of course must be done evenly around the flange, the nuts each being given equal portions of a turn so that the pressure under them will be even. Some engineers, at the beginning of applying pressure, work the nuts on opposite sides of the flange alternately, thus evening the strain as nearly as possible over the entire surface of the gasket. Under this treatment the gasket is first merely compressed, this, however, is not usually sufficient, for the material must actually undergo a slight amount of plastic flow sufficient to fill the low places in the faces of the flanges whether these irregularities are due to tool marks, defects in the metal or strains caused by drawing up the bolts. With the addition of the extra pressure necessary, which is applied by working adjacent nuts in turn, the crushing point of the material must not be reached nor the plastic flow be excessive or the joint will be weakened.

Once in service, the continuous pressure on the gasket will cause it to set, permanently destroying some of its elasticity so that it will not come completely back to its original thickness, oft times necessitating supplementary take up on the flange bolts. In addition to the installation pressure on the gasket, there are usually compression strains put upon the gasket due to temperature variations and structural strains accompanying service of the piping or fluid containing equipment. This is usually of a varying nature and calls for sufficient elasticity in the gasket that it will maintain a sealing pressure when the service strains are removed. Then, too, nearly all materials undergo changes in their physical characteristics with changes in temperature. High temperatures are ordinarily accompanied by a reduction in elasticity and an increase in plasticity resulting in a general weakening of the compression and tensile strength of ordinary gasket material.

It is evident, then, that the question of gasket pressure is extremely important to the engineer in charge of a plant. The rule of thumb in common practice, when installing a gasket, is to take up on the bolts to the point where judgment would indicate the pressure would be amply sufficient for the service, then check for leaks after the gasket has been in use for a time, if a leak does occur supplementary tightening up should be done but, as a safety measure, only while the joint is not subjected to fluid pressure. An excessive leak developed during service, however, usually calls for a new gasket as in nearly all such cases the gasket will have been found to be injured.

The proper thickness of a gasket is ordinarily a function of the condition of the flange face, the more pronounced the irregularities the thicker the gasket

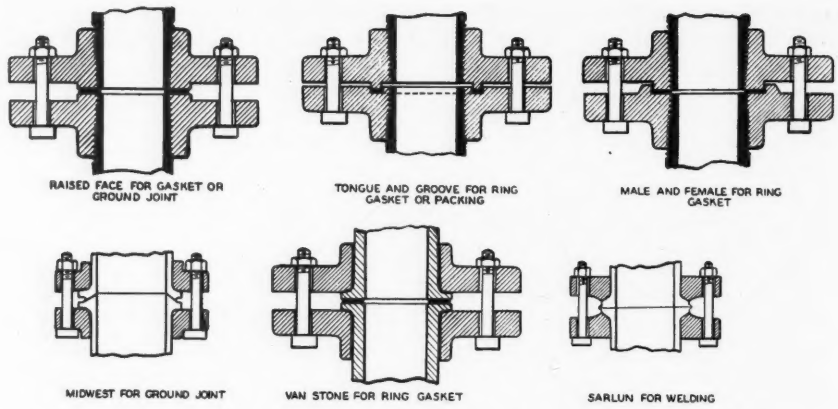

RAISED FACE FOR GASKET OR GROUND JOINT
TONGUE AND GROOVE FOR RING GASKET OR PACKING
MALE AND FEMALE FOR RING GASKET
MIDWEST FOR GROUND JOINT
VAN STONE FOR RING GASKET
SARLUN FOR WELDING

Fig. 2. Flange joints with matched faces

must be so that the deformation that takes place will not be excessive.

Relation of Pressure to Compression

Just what happens to some of the mechanical properties of gasket materials under compression may be judged from the curves in Figs. 4 and 5 which were given by F. C. Thorn in an article in Industrial and Engineering Chemistry. All these tests were reported as having been conducted on small disks, 1⅛ in. in diameter and ⅛ in. thick, except the strip-on-edge material which was tested in the form of a gasket 1⅝ by 2 by 3/16 in. In all cases the load was carried to 500, 2000 or 10,000 lb. per sq. in., whichever would be nearest a reasonable commercial load for the material under test, and held at this pressure for 24 hr., then the load was relieved and the retraction curve plotted. The plastic flow under load and also the elasticity, or lack of it, are clearly revealed. Some of the plastic flow is due to the dying out of the stresses within the disk, but part is due to frictional slippage between disk and platen, which is also the case with gaskets between flanges. The effect heat has upon the compression characteristics of these same materials is shown in Fig. 5 which are the results of tests conducted exactly the same as those reported in Fig. 4 except that the disks were held between platens steam-heated to 212 deg. F.

Simple as the work of replacing a gasket seems to the engineer of a plant, the development of present practice in the design of flanges and selection of gasket materials has taken years and much research is yet to be done before this phase of engineering has been brought completely out of the experimental stage.

(To be continued.)

Nutty Business

California Walnut Growers Assn. builds new storage utilizing damp muslin as cooling agent.

THIS YEAR the California Walnut Growers' Association built what is believed to be the largest air conditioned cold storage room in existence, capable of holding 17 million pounds of the well known "Diamond" and "Emerald" Brand walnuts. The temperature maintained in this room averages between 36 and 40 deg. F., and the relative humidity is kept close to 65 per cent. Between the months of April and November, refrigeration is required for holding the walnuts in first class condition, until sold.

The new plant is located at Vernon, a suburb of Los Angeles. The building is a one-story structure and is 700 ft. long, 400 ft. wide, and 30 ft. high. Double railroad tracks extend down the center of the building, roughly one half of which is devoted to dry storage and the other half to refrigerated storage. The refrigerated storage room is approximately 600 ft. by 175 ft. by 22 ft. high. The floor is of concrete but is otherwise not insulated. The outside walls have 6 in. of granulated cork insulation; on the east there is a demountable panel wall, containing 4 in. of shredded

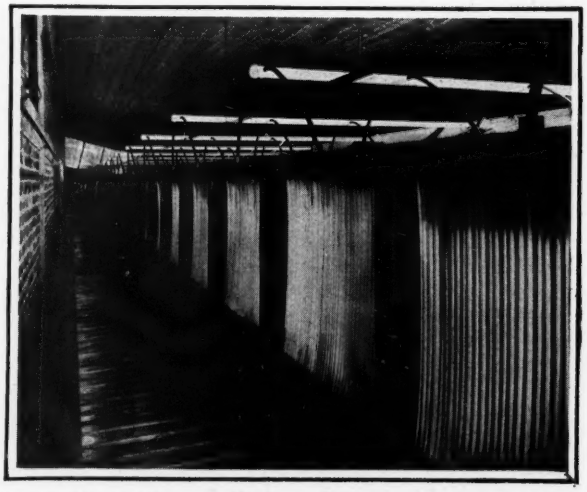


Fig. 1. Cold brine is distributed over these folds of unbleached muslin to give a large cooling surface

redwood bark insulation; the ceiling is also insulated with this same material. The demountable east wall is built in sections about 10 ft. in width to the full height of the storage and may be easily moved to accommodate the needs of the management in providing extra dry storage in cold weather, or for processing operations.

One of the unique parts of the refrigerating system is the method of air conditioning developed by the consulting engineer, Paul A. Scherer. One of the photographs shows a portion of the 6,000 yd. of unbleached muslin folds, installed in the redwood frames through which the return air passes, en route to the suction of the two 75,000 c.f.m. American Blower fans. Cold brine is distributed over the surface of the muslin from supply headers which may be seen above the frames. This air conditioning compartment is separately insulated from the main refrigerated room and is approximately 22 ft. wide by 150 ft. long, arranged in two floors, the upper of which is shown in the picture.

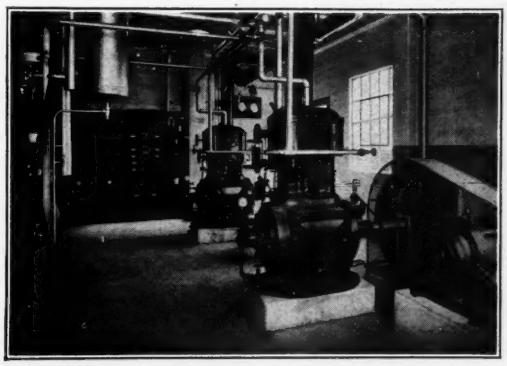


Fig. 2. Two 9x9 compressors furnish the refrigeration

Conditioned air is distributed to the room through galvanized iron ducts and returned through ducts along the outside walls. The brine is cooled in a multipass shell-and-tube cooler, 42 in. diameter and 15 ft. long, equipped with an accumulator and ammonia float valve control. The brine is delivered to the air conditioning chamber by two 450 g.p.m. Fairbanks-Morse centrifugal pumps.

Refrigeration is supplied by two 9 by 9 in. Frick ammonia compressors of the enclosed type, driven through V-belts by Fairbanks-Morse motors. Either machine is capable of maintaining the temperature after nuts are cooled but both are required for quickly lowering the temperature after new shipments are put in storage. There are four horizontal shell-and-tube condensers mounted above the ammonia receiver, which is equipped with a purger.

FOR LOW-WATER periods and nightly winter peak load, the municipal light plant at Beaver City, Utah, operates a 125-hp. Caterpillar Diesel engine driving a 90-kw. Warren Electric Co. generator and belted exciter at a cost stated by Superintendent Thompson to be 0.84 cents per kw.-hr., using fuel oil which costs 9 cents a gallon. The main unit is a 275-kv-a. Westinghouse alternator at 2400 v. driven by a Pelton wheel at 300 r.p.m.

"The Unit Horsepower"

By C. O. Von Dannenberg

THE YEAR 1936 commemorates the advent of a man, who has left upon the mechanical world, a mark of indelible fame.

To the average person the term "horse-power" is somewhat of a mystery. What does it mean and why should it be used in an age where, for over 30 years, the application of mechanical contrivances has so largely displaced the horse as a means of motive power?

The name, although introduced by Savery, was not definitely defined until James Watt (1736-1819), a Scotsman, the developer of the first practical steam engine, undertook certain tests in an effort to find out the relation of the power of his engine to that of a horse.

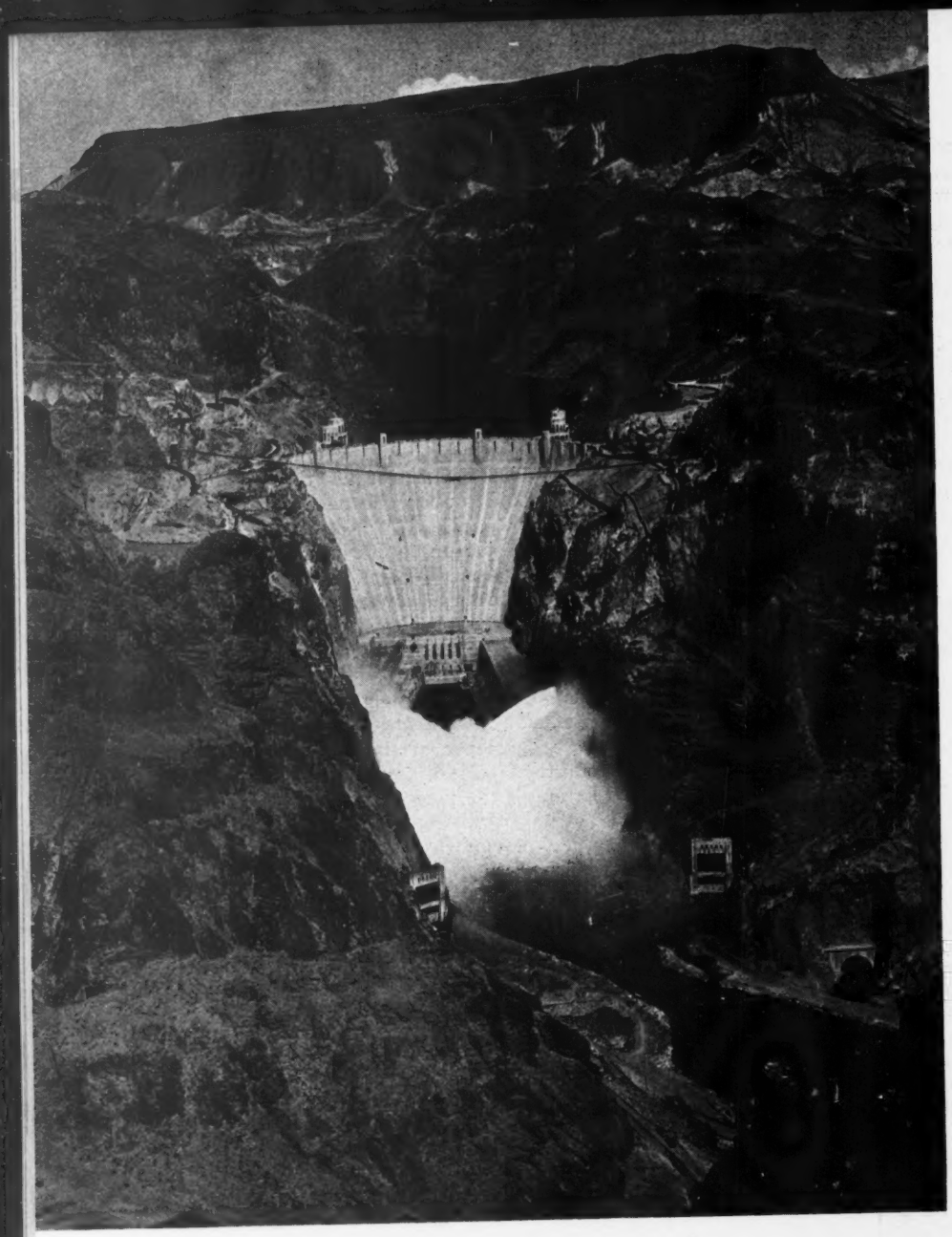
Watt's first patent was issued in 1769 and he was frequently asked about the number of horses one of his engines would replace, as at that time the horse was the common beast of burden and it was about the only means of motive power generally available.

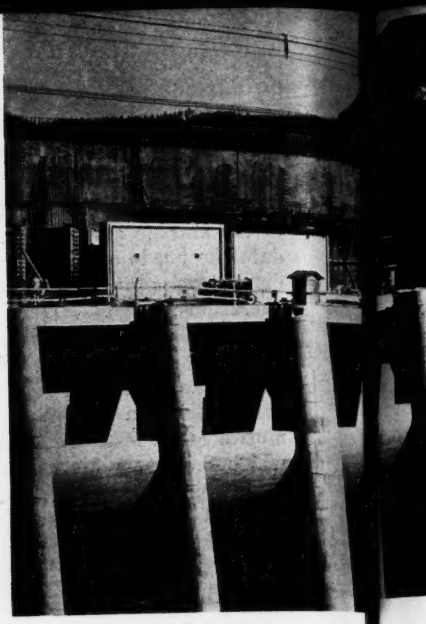
Watt is reported to have derived his unit value through actual experiments carried out in the City of London at Messrs. Barclay and Perkins' brewery. He used for these experiments some horses belonging to the firm. The experiments consisted in having the horses raise a weight from the bottom of a well by means of a rope pulled horizontally, which in turn, passed over a pulley at the top of the well and then to a weight below. He found that a horse could walk at the rate of 2.5 miles per hour and at the same time raise a weight of 100 pounds. This was equivalent to:—$2.5 \times 5280 \times 100/60$ or 22,000 ft. lb. per min. To this value Watt added 50% to allow for friction and loss in the engine, from which be obtained the value of 33,000 ft. lb., which is the one used at the present time. The fact that an allowance was made for friction and losses, shows how clearly Watt understood the details of the problem he had to solve and this personal characteristic was one of the outstanding qualities of his whole career, that he always considered every factor to be accounted for.

General Morin, who did much experimental work at Metz in 1837-1838 in connection with the laws of friction, estimated the power of a horse to be 26,150 ft. lb. per min.

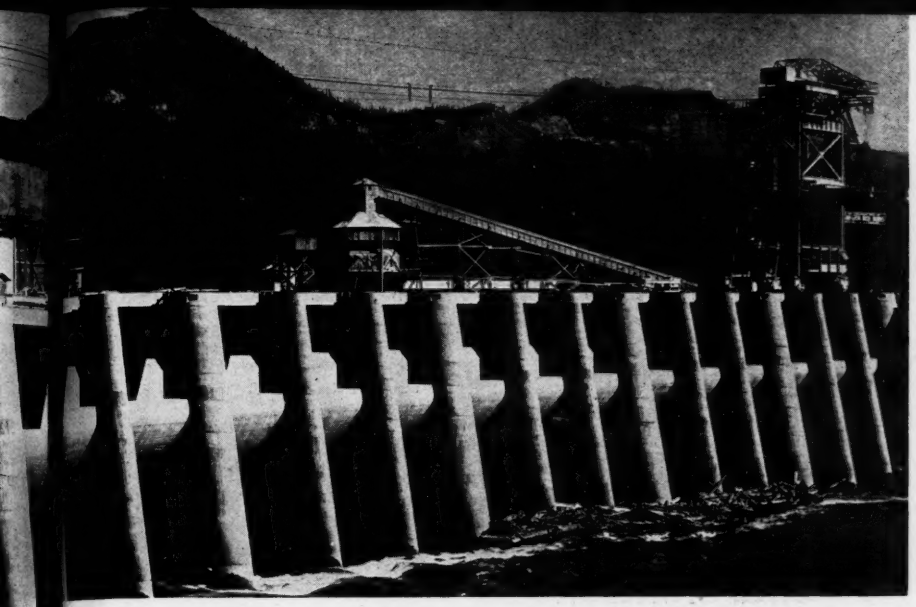
The Unit Horse-Power can be expressed in other ways, as 500 ft. lb. per sec. or 1,980,000 ft. lb. per hr., the values being called, respectively, a horse-power-second or a horse-power-hour.

It is a very remarkable tribute to the genius and investigations of James Watt that, we now, at the 200th anniversary of his birth, still are using the identical unit of work, that he so clearly defined.





Progress



s on the Federal Power Projects

THESE pictures show the progress that is being made in the construction tion of the large Federal power and flood control projects. At the upper left is a view of Boulder Dam, taken on September 11 as water was released during a test of the 12 needle valves, six located in the outlet house on each side of the canyon. Lake Mead winds upstream in back of the dam; Fortification Hill in the background.

At the lower left is a view of the two cities that have sprung up to house those building Grand Coulee Dam on the Columbia River. In the foreground is the permanent government city Coulee Dam while across the river lies Mason City, the contractors' camp where nearly 5000 families live. This city is entirely electrified, with no chimneys.

At the top center is a view of the upstream face of the large Bonneville Dam also on the Columbia River. This project designed to make power, improve navigation and control floods is being carried out by the Army Corps of Engineers.

A close up view of the sheer wall of Grand Coulee Dam is shown in the lower center. This view shows a grooved section across which will be joined the next block of the dam.

At the upper right is a photograph of a substation for a new R.E.A. rural line constructed at a cost of only $760 a mile, a record in low cost construction.

Below is a recent view of the Lake Mead being formed by Boulder Dam. This lake is now 100 miles long, and it is becoming one of the principal recreational sites of the far west.

The Bonneville photo was furnished by P.W.A., the Rural line photo by R.E.A. and all the others by the Bureau of Reclamation.

Internal Combustion Engine Governors*

Demand Both Careful Design and Construction

By G. C. WILSON

Associate Professor,
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University of Michigan,
Ann Arbor, Mich.

GOVERNING of engines is accomplished by controlling the input energy to meet the demand for output power. There are many ways in which this can be accomplished. The hit-and-miss type of governing has been a popular way of controlling Otto-cycle engines, but this scheme of varying the frequency of working cycles does not give good speed control. Methods of governing which control either the quantity of the fuel and air or of the fuel alone furnish better performance. The Hesselman fuel oil engine maintains the proper air-fuel ratio by placing both air and fuel under governor control.

All Diesel engines govern by regulating the fuel supplied to the nozzles. The directness of this control makes good governing possible, for there is but little time lag between the fuel pump operation and the next working cycle. Different manufacturers have utilized various means for controlling the amount of fuel. The most common way is to release the pressure in the fuel discharge line and thus control the time of "cut-off" of the fuel supply.

Some manufacturers vary the time of "start-of-injection" in place of the time of "cut-off" with load, while others go further than this and vary both the starting and stopping time of injection. Whatever scheme is used, some actuating mechanism is required, and it is with the problem of this mechanism—the governor itself, that this paper is concerned.

Relay Type

Before going into the problems of governor design, it might be well to point out the difference between the direct-control and the relay type of governor. Where the load conditions are such as to demand unusually good control, the expense and complication of a relay type governor is warranted. Since the engine element of this type of governor does not have to furnish the power for controlling the input energy to the engine, it is possible to obtain almost any desired degree of control. Furthermore, any number of compensating features may be added to the control mechanism. Such governors can be made to operate on 0.01 per cent speed change. The relay type of governor, however, is a machine in itself and is a broad subject and this paper is limited to those governors of the direct-control type.

The direct-control governor has two functions. First, it must act as a speed meter to measure the speed of the engine, and second, it must act as a motor to move the power-controlling mechanism. To do this effectively, it must have the proper amount of regulation, stability, sensitivity and power. It must function properly not only while it is new, but also after it has been subjected to considerable use. With this in mind, the design should be such as will reduce both the number of points where wear will occur and the wearing tendency at these points. The use of high grade materials at these points will help to reduce wear, but even so, provision should be made to off-set the effects of such wear as is unavoidable.

Governor Characteristics

Essential characteristics of a good governor are: 1, Closeness of regulation; 2, stability or positiveness; 3, sensitivity and rapidity; 4, power or strength.

Closeness of regulation is usually stated in per cent as speed regulation between loads a and b and equals

$$\frac{N_a - N_b}{N}$$

where:

N_a = R.p.m. for load a (the higher speed);
N_b = R.p.m. for load b (the lower speed);
N = Arithmetical mean of the two extreme speeds.

The term speed-droop has nearly the same meaning as regulation. It is defined as the decrease in the steady speed of an engine caused by an increase in load from a no-load condition to full-rated load, without change in the adjustment of the governor. This

*From a paper presented at Ninth Oil and Gas Power Meeting of the Oil and Gas Power Division of the A.S.M.E. held at Ann Arbor, Michigan, June 24-27, 1936.

decrease in speed is expressed as a per cent of normal rated speed. Where the load conditions require close regulation, it can be reduced to 2 per cent without undue complications.

When speed-droop is reduced to zero, then the governor is said to be isochronous. Such governing has been attempted, and at first consideration it might seem to be the ideal goal towards which to work. However, there are many reasons why it is undesirable in the case of the direct-control governor. In the first place, it has no stability or ability to hold a definite position. For driving either alternating or direct current generators in parallel, there should be an appreciable speed drop with increased load so that the governor action will divide the load between units. A speed-droop of 4 to 6 per cent is desirable for such cases.

Some form of synchronizer is required for engines driving alternators which must be operated in parallel or maintain a standard frequency. This may be accomplished by a change in governor adjustment such as changing the fulcrum of a floating lever or varying the tension on an auxiliary spring.

When a governor has stability or positiveness in its operation, it has ability to take and hold a definite position for any given speed, and it will return to the position of equilibrium after it has been displaced from that position. This eliminates any "hunting" or "racing" of the prime mover. Stability of a governor is insured by providing a restraining spring tension which increases more rapidly than the centrifugal force of the governor weights. This stability must be sufficient to prevent any appreciable movement of the governor due to the reactions from the control mechanism.

Sensitivity is defined as the minimum change in speed at any governor position which will cause a change of governor position. Rapidity or quickness is determined by the time required between the change of load and the settling down of the prime mover to its proper speed. These terms are closely related and are affected by some of the same factors.

Sensitivity

For accurate governing, the governor parts must be sensitive enough to always assume the same position for any given speed and must respond to even slight changes in speed. Opposed to this action is the friction in the governor itself and the force required to move the control gear. Any friction interferes with the sensitivity of the governing action, and should be reduced to the minimum. Some internal friction may be used to limit governor oscillation, but the amount that can be successfully used is decidedly limited.

Friction of rest is greater than the friction of motion, and unless sufficient vibration is present to reduce or eliminate the excess friction of rest, some static force may be required to keep the governor slightly on the move in order to obtain quicker action. Where excessive friction of rest is not overcome, the governor movement is jumpy instead of being the smooth movement required for good control.

Lack of sensitivity in a governor is indicated when the per cent regulation is different for increasing than it is for decreasing speeds. Increasing the movement of the governor sleeve will decrease the effect of lost motion and increase the sensitivity of the governor. It should be not less than 1 in. for small engines and greater for large units. Increasing the mass of the moving parts will decrease the rapidity of promptness of a governor.

Effect of the flywheel must be kept in mind in connection with governing. If the flywheel is very small, then any change in loading quickly gives a large change in speed. In this case, the governor does not have much time to act and must have great rapidity in order to overcome the lack of flywheel capacity.

Power or strength of a governor furnishes the necessary energy to do the work of regulating the engine. All of the requirements of good governing depend upon the force furnished by the governor. The strength of a governor may be increased by increasing the centrifugal force. This increases directly with the weight and radius, but, as the square of the angular velocity. For this reason governors are often run at speeds higher than engine speed.

Construction

Proper choice of features for a governor requires that the designer consider both the engine and the type of load which it must operate. If there are to be frequent, sudden, or violent load changes, or a combination of these changes, provision should be made in the original design. The centrifugal type governor can be improved for sudden load changes by adding some inertia effect. The fact that governors operated at high speed usually are quite sensitive makes them susceptible to sudden and wide variations in engine speed.

Present day governors are of the centrifugal type in which the movement of revolving weights is opposed by one or more springs acting either under tension or compression. The resisting force of the spring should be as close to the weights as possible in order to avoid undue strain and wear on the pivots.

Use of springs permits placing the governor in any convenient position, and also has the advantage that the spring or springs can be designed to meet the requirements of speed control. Moreover, it permits enclosing the governor where it can be well lubricated and protected against both dirt and breakage. In recent years, ball and roller bearings have been used to good advantage to reduce internal governor friction.

Any governor should provide ample protection against over-speeding of the engine. It is not sufficient to simply provide a "safety-stop" at the outward position of the governor; protection is also needed against failure of the governor's drive. The governor drive should be taken from a point on the engine which provides the smoothest possible drive. In some cases, a flexible connection between the governor and its driving element will improve operation.

Even though a moderate amount of vibration may be beneficial in overcoming excessive friction of rest, the governor parts must be accurately machined and properly fitted to give good performance. Moreover, the governor must have simplicity, accessibility, and proper adjustments conveniently located.

Buy Steam— NOT —Freight Charges

Selection of Fuel by the Performance Method Brings Steam Cost to a Minimum

By C. O. DRULINER

INASMUCH as the amount of steam required per unit of work put out by the prime movers in a power plant is largely fixed by the design of the apparatus, little can be done to reduce the cost of power at this point. Therefore, the greatest savings, to be made by a power station, are made at the fountain head, the boiler house. The greatest savings in the boiler house can be made through buying the coal that will produce at the lowest steam cost per 1000 lb.

It is true there are several things that may be done in many boiler plants to decrease the cost of steam, but the greatest opportunity to make a boiler plant show on the black side of the ledger is the right coal at the right price.

Each boiler plant has its own peculiar conditions that must of necessity govern the coal most economical to burn in that particular plant, or to state it differently each boiler plant is limited as to the kind of coal it can burn most efficiently.

As an example, a plant equipped with natural draft chain grate stokers can burn a high volatile coal, high in ash and with a fairly high fusing point; while a forced draft underfeed stoker equipped plant performs best with a high fusing point coal, having a lower volatile and a higher fixed carbon ratio.

Then again some plants are designed and built with but one idea in view and that is extremely high efficiency, although it is at the cost of unit operation.

It is true, it is the duty of the head of any power house to operate his boiler plant at the highest possible efficiency so long as he does not increase the cost of steam by so doing.

I have in mind a modern plant that gets a high efficiency, yet the steam cost per 1000 lb. is about 8 cents higher than another plant not nearly so modern and where the apparent overall efficiency is not nearly so high.

The idea that I am trying especially to stress is that no matter how you obtain it, it is the low cost of steam that makes the profit in the end and the greatest factor in obtaining this end is the right coal at the right price used rightly.

Here is where close coöperation of the boiler plant management and the purchasing department (no matter whether it is a hired purchasing agent or the owner of the plant), is absolutely necessary, because it requires work, study and patience to overcome the natural limitations of that particular boiler plant.

Controlling Factors in Selection of Coal

The triumvirate that finally controls the fuel cost is first, operating methods; second, proper adaptation of the coal to the particular situation; third, market values.

In selecting a coal that will give the lowest steam cost it is necessary to tabulate the conditions that a coal must meet in your particular plant.

When you have done this, take the published proximate analysis of all the coals available and select those that will most nearly meet your conditions, never losing sight of the item of freight rate, for in this one item, is great waste of fuel money.

As an example of what freight rate means, let us take two coals that cost $1.00 a ton at the mines. The freight rate on one is $2.75 while on the other it is $1.85. The B.t.u. of the $3.75 coal is 14,000 while that of the $2.85 coal is 12,000.

In reference to the first coal 1 cent will purchase 74,667 B.t.u., while of the second coal 1 cent will purchase 84,211 B.t.u., or in other words, $3.75 spent for the $2.85 coal will purchase, delivered, 31,579,125 B.t.u. or 3,579,129 more B.t.u. than it would have had it been expended for the $3.75 coal, all because of the freight rate on the higher priced coal.

Now 1 cent per 1000 lb. of steam, roughly speaking, means a saving of $1000 for every 5000 t. of coal burned.

If you are buying the $3.75 coal and are getting a cost per 1000 lb. of steam of say 22 cents and you

switch to the $2.85 coal you should make a steam cost of $0.195 per 1000 lb.

Not all coals that can be purchased delivered for $2.85 and show an analysis of 12,000 B.t.u. will answer your purpose; perhaps there are but one or two that will do so and that is where work, study and patience come in.

Performance Method of Selecting Coal

The method used by us in selecting both the best and the second best coals for our plant may be of interest. We have found it advisable always to have a second source of supply in the event something happens to hold up the first source, thereby giving us for the money the most coal possible to be obtained.

We notify the several coal companies, whose coal is in line with our requirements, that we are going to be in the market for coal for the next year. We do this in plenty of time to make all necessary tests. We ask these coal companies to have a representative call on us at their earliest convenience.

When the representative calls, we tell him we are ready to give his coal a test, providing he will guarantee us a coal cost per 1000 lb. of steam, and that cost we place at a figure that we know it is possible to maintain with the coal we are now burning.

If he agrees to guarantee us a coal cost per 1000 lb. of steam not greater than the figure we name, we buy five days supply from him, with the understanding that the coal company send their own combustion engineer to our boiler plant to supervise the burning of their coal, so there can be no comeback that the cards were stacked against them.

When the coal and the combustion engineer arrive, we turn the boiler room over to him (always keeping a competent man to see that nothing is done to jeopardize the continuity of operation), with the understanding that the test must be made with actual operating conditions over, at least, three 24-hr. periods.

The coals that make the predetermined steam costs are also tested to see if they will develop 300 per cent rating and do it for at least 5 hr. without objectionable fusing of the ash.

We have found that there are usually but two or three coals in a given field that can produce these results and it is usually not difficult to pick the outstanding coal in this group, as the performance of one coal nearly always outshines the others in at least one of the three necessary attributes.

From these tests we have ascertained the best coal for us to buy and we now have the ground work for the lowest possible steam costs our boiler plant will produce. It is now up to supervision to make the plant efficiency as high as possible and by eternal vigilance keep it there.

You are now putting steam into the lines at the lowest possible cost with any given equipment.

Louis Joliet and Father Marquette are recorded as being the first to discover coal in territory now part of the United States. This was in 1673 and the location was north of the Illinois River near the present site of Utica, Ill. The first mine opened was near Richmond, Va., about 1730 and mines in that vicinity were in commercial operation by 1750.

Thermometers vs. The Frost Line

By H. A. Cranford

AN ENGINEER acquaintance writes: "I have heard and read quite a few discussions about where the frost should be located on the suction line to the compressor. Some engineers claim they get the best results when the frost is brought back to the suction valve just off the compressor, while others claim better results when the frost is brought back to where the suction line emerges from the brine tank. What do you think about it?"

To begin with let me state that it is a pity that the suction lines are not so well insulated that it would be impossible to tell where the frost stopped on it. We would then be compelled to pay more attention to thermometers, gages and ammonia tables, and we would get far better results both in quality of ice and economical operation. There would be fewer compressors wrecked from having slugs of liquid ammonia passing through them, fewer rods and packing ruined, and less heating from highly superheated gases.

There are some good engineers, however, who operate their plants almost entirely by the appearance of the frost on the suction lines and they get results alright, but, as a rule they are men who have operated their particular plants a long time. I do not believe that there is an engineer alive who can go into a plant that is new to him and get the best results by operating from the appearance of the frost line. He will have to get acquainted with the plant first.

The man who states that he gets the best results frosting back to the compressor, may be right. Also the one who frosts to the suction valve, also the man who brings the frost just out of the freezing tank. Each plant is an individual unit of machinery, and I have yet to run across two plants, regardless of uniform layout and construction, that will produce the same under identical operating routine. So each man may be right for his particular plant, but if the evaporators were flooded type, with a dry gas compressor, it would be dangerous, to say the least, to operate it with the line frosted back to the compressor, unless there was a separator or a surge drum in the suction line that would keep slugs of liquid ammonia from surging over into the compressor cylinder. Even if it were a wet gas compressor, unless it was equipped with clearance pockets that could be quickly adjusted, although many machines, originally designed for dry or superheated gas compression, run along for years with frost carried back to the foundation bolts. How they have stood the conditions of such operation is a

mystery to many engineers. The power loss when operated under these conditions is terrific.

I have been told that my vocabulary of "cuss words" is rather complete, but I was in a compressor room recently, where, could I have understood just what the compressor was trying to call the operator, I would have had a new lesson in wicked expression. I did understand compressor language well enough to know that it was trying to tell the operator that it was being overloaded with liquid ammonia. I placed a thermometer in the well of the discharge manifold and the temperature was 90 deg.

The length and size of the suction lines, number of bends in them, condition of the insulation, temperature and humidity of surrounding atmosphere, condition of valves and packing rings, as well as many other minor things, have a decided bearing on just where the frost line will stop on the suction line when the plant is operating at its highest efficiency. There may be two—even more—evaporators handled by the same compressor, and there may be a wide difference in the temperatures carried by each of them. Therefore the frost line on a common suction wouldn't mean a thing.

Some of these days, because of the advent of electric household and small commercial machines, plant owners are going to have to go in for more rigid economy in the manufacture of ice. This means that compressors will have to have variable clearance, and ammonia fed to the evaporators through automatic control and possibly through venturi meters that will measure the amount of ammonia being fed to the evaporators, making it possible for the operator to know in advance, exactly how much refrigeration he is producing, and predetermine what the output will be. More attention will be paid to efficient insulation of tanks, storage rooms and suction lines, and engineers will not be expected to refrigerate the whole atmosphere. It has been a source of wonder to me to go into otherwise good plants owned by up to date business men and find from 25 to 500 ft. of brine and low side ammonia lines without a particle of insulation on them, often in rooms where the temperature in summer time goes as high as 110 deg.

I have spoken to engineers about it while in their plants and had the reply, "It doesn't amount to as much as one would imagine for after the plant is operated continuously for a while, the frost builds a thick coating, and you know ice itself is good insulation, or we would not have to defrost the coils in our storage room." It is good insulation alright, but the maintenance on that insulation is extremely high.

But back to the question, "Where to stop the frost on the suction line." Always take into consideration local conditions, atmospheric temperatures, humidity, number of evaporators carried and the temperatures in the evaporators. Learn to use thermometers and gages, and what they mean in the ammonia tables. If you are carrying a brine temperature of 14 deg., your ammonia tables will show you that the gage pressure should be about 20½ lb. The corresponding temperature of the ammonia in the evaporator is about 6 deg. My experience is that it is advisable to carry 2 to 6 deg. superheat. This means that your suction gas temperature entering the evaporator would range from 8 to 14 deg. At this temperature you will find that you can regulate the expansion valve so that the discharge temperature will be 220 to 240 deg. I try never to let the temperature of the discharge go higher or lower than these figures. If you cannot carry these temperatures you had as well look for trouble in the compressor or impurities in the system. I try to keep the temperature of the ammonia in the evaporator within 6 or 8 deg. of the brine or room temperature. This keeps the suction pressure at the highest pressure commensurate with temperatures carried, and keeps the compressor at high efficiency.

Now after maintaining these temperatures and pressures for a few hours, you can observe the frost line and get a fair idea where the frost will stop. After that, a glance at the frost line will show you that a change is taking place, but does not tell you what to do.

Don't forget that frost lines may mean much or little. Gages if not tested regularly, may be a few pounds off, and are sometimes slow to show a change. Good thermometers are easily read accurately, show changes quickly, are seldom incorrect, and are inexpensive. And you are dealing with temperatures. Therefore run your plant with good thermometers and the frost line will take care of itself.

Research on Air Conditioning

SINCE 1919 the American Society of Heating & Ventilating Engineers has conducted research work on selected problems which have been studied in the laboratory or at coöperative institutions where the details are worked out by a technical advisory committee of experienced engineers in the field who serve without remuneration. At a recent meeting of the committee on research, it was reported that authorized studies were being made on five projects at the laboratory in Pittsburgh and eight coöperative studies are being conducted at the University of Minnesota, Marquette University, University of Illinois, University of Illinois Medical College, Harvard School of Public Health, Michigan College of Mining and Technology and Case School of Applied Science.

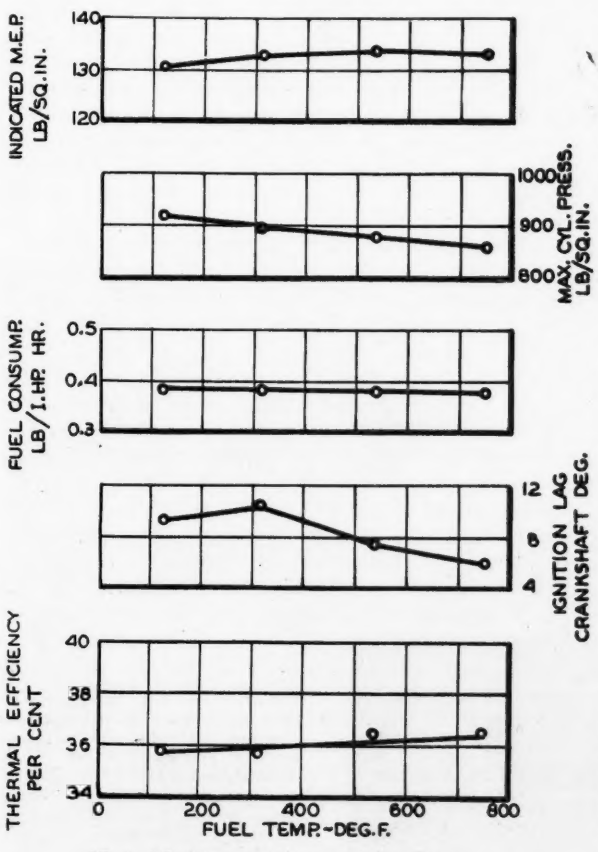
Among the problems now under investigation are the following: A study of comfort requirements for summer cooling to check the extent to which varying climatic conditions in several geographical locations affect the desirable indoor temperature; a determination of the frictional resistance to the flow of air through round ducts and fittings to be followed by a comprehensive study of rectangular ducts and fittings; an investigation of the time and rapidity of change from the summer to the winter comfort zone; a study of air movement as related to various temperature and humidity conditions to determine what constitutes a draft; a study of the relative conductivity of concrete mixtures containing various special light aggregates; atmospheric dust and air cleaning devices; relation between temperature velocity, direction and location of entering air stream on ventilation conditions within occupied spaces; the use of refrigeration in the treatment of air; air cleaning and its effect on health in the treatment of diseases; heat transfer between air and fin tubing; odors as a limiting factor in volume of air recirculated in occupied spaces; corrosion in steam heating systems.

Influence of Oil Temperature On Combustion

FOR SOMETIME PAST the possible influence of fuel oil temperatures on combustion properties in the Diesel engine have been discussed and recently experimental results, of injecting fuel of different temperatures into the pre-combustion chamber of a single cylinder, four cycle water cooled compression ignition engine were reported in N.A.C.A. Technical Note 565 prepared by H. C. Gerrish and B. E. Ayer.

The engine was operated at 1500 r.p.m. with a compression ratio of 13.5. Indicator cards, exhaust gas samples and engine performance data were obtained for a range in fuel temperature from 124 to 750 deg. F. The results of these investigations are shown in accompanying curves.

A common-rail fuel-injection system was used with a hydraulically controlled fuel-injection valve operating at 8800 lb. pressure. The injection characteristics of the system and the appearance of the fuel spray were studied by injecting the fuel into the atmosphere. In the test the fuel was heated by passing it through an electric heater inserted between the pump and injection valve.



Effect of fuel temperature on engine performance

Results showed that heating fuel oils to 750 deg. F. increased the injection period, changed the rate of injection and eliminated the spray core. Engine tests showed that ignition lag, rate of pressure rise and maximum cylinder pressure were reduced. The indicated mean effective pressure, the fuel economy and the thermal efficiency were slightly increased as shown by the curve.

Operation of the engine on 750 deg. F. oil was smoother, the exhaust clearer and the carbon formation in the combustion chamber considerably less than for 124 deg. F. oil.

Smoke Abatement

SOME SPARKS from the recent fuel meeting of engineers sponsored by Appalachian Coals, Inc., at Cincinnati, are as follows: From J. E. Tobey, manager of the Company's engineering division, "smoke abatement and better combustion are partners, hence smoke abatement authorities and fuel engineers are partners to do a common job." From W. E. E. Koepler, vice-president, Smoke Prevention Association, "The time when smoke was the badge of industry has given way to the conviction that smoke means waste. . . . Smoke has no defense. . . . With the public rapidly taking to air conditioning, coal men must take warning to attain the highest possible standards of combustion in order to retrieve and maintain coal's important place in modern life." From William G. Christy, smoke abatement engineer of Hudson Co., N. J., "Coöperation of coal men, industries, the public, railroads and smoke prevention groups is most important. Elimination of smoke is a major community problem and someone has to keep at it continuously. Where smoke bureaus have been discontinued, the results of several years' effort are usually lost. The problem is one of mass education." From Frank A. Chambers, chief smoke inspector, Chicago, "Grime, soot and dirt can be removed from soiled surfaces, but effects of oxides of sulphur are irreparable. The public is waking up to this menace and, to avoid ill-advised legislative action, the coal industry should make a thorough study of possible economic solutions of this problem." From Frank H. Lamping, executive secretary, Smoke Abatement League of Cincinnati, "Total average soot fall of 33.3 t. per sq. mi. per month has been found, and of 50 t. per sq. mi. per month in winter. In the business center, the fall is 120 t. per month and in downtown Chicago, 98.8 t. in 1934-5 and 68.6 t. in 1935-6 per month per square mile. Part is due to automobiles and natural causes, but the rate of deposit during winter months is practically double that for summer months. Americans have come to realize that cleanliness is a virtue and will increasingly strive to protect that virtue." From Louis T. More, president, Smoke Abatement League of Cincinnati, "The present question is how to solve the smoke problem in the homes. Coal men should know their customers and their furnaces and see that each one gets the right coal and learns how to burn it properly." From Gordon D. Rowe, chief smoke inspector, Cincinnati, "Men should not leave furnace tending to the women. My furnace is fired only twice in 24 hr."

RECENT 850 lb. non-condensing turbine with automatic extraction at 400 lb. believed to set new record for industrial plant service. As the common grid valve used for automatic extraction is limited to a pressure of about 200 lb. a special arrangement of six plug valves in a steam chest integral with the cylinder is used for the 400 lb. extraction point.

Trend Upward in Industrial Pressures

By K. S. KRAMER

Turbine Engineer, Westinghouse Electric & Mfg. Co.

TEN YEARS AGO steam pressures over 400 lb. were just beginning to be utilized in the central stations, but the rapidity with which this trend was followed by industrial plants is illustrated by a recent turbine installation at the Barberton, Ohio, plant of the Pittsburgh Plate Glass Co. The turbine is of the non-condensing bleeder type designed to bleed automatically at a pressure of 400 lb. per sq. in ga., considered only a few years ago in the high pressure class for boiler pressures. This is believed to be the highest bleeder pressure for which any automatic bleeder turbine has been designed.

Normal condition of steam at the throttle is 825 lb. per sq. in. ga. and 750 deg. F. T. T. with maximum of 850 lb. and 825 deg. F. Normal exhaust pressure is 140 lb. per sq. in. ga.

The complete unit consists of: A 5000 kw. turbine; a 5000 kw., 0.80 P.F., 60 cycle, 3 phase, 2300 v. a.c. generator; a reduction gear and a 1000 kw. d.c. generator. The turbine operates at 3600 r.p.m. and is connected directly to the a.c. generator. The d.c. generator is driven from the end of the a.c. machine through a reduction gear which reduces the speed to 720 r.p.m. This d.c. generator and the reduction gear were taken from an existing unit in the plant and applied to the new installation.

A longitudinal section of the turbine is shown in Fig. 2. In effect, it is a tandem turbine built into a single cylinder and rotor. Steam is taken from the main header, through a strainer and oil operated throttle valve to the main or high pressure steam chest. The steam chest has seven plug type valves which are controlled by the main governor. Each valve controls the flow of steam to a corresponding group of nozzles. After expanding through the nozzles, the steam passes through a Rateau or single velocity impulse stage and then to the reaction element preceding the bleeder zone.

The bleeder valve, instead of the more common grid valve, consists of six plug type valves in a steam

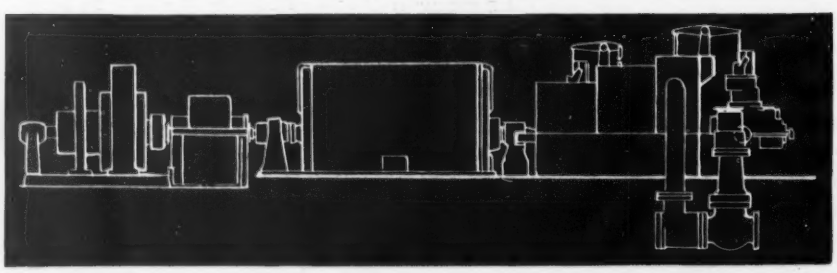


Fig. 1. This 5000 kw. turbine is designed to use a maximum steam pressure and temperature of 850 lb. and 825 deg. F. bleed at 400 lb. and exhaust at a pressure of 140 lb. The turbine drives a 3600 r.p.m., 5000 kw., a.c. generator direct and, through gears, a 720 r.p.m. 1000 kw., d.c. generator

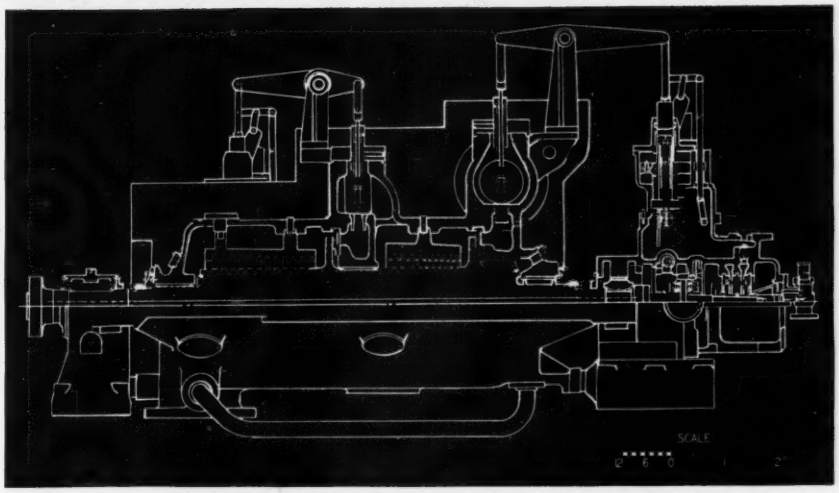


Fig. 2. Longitudinal section of the tandem turbine built into a single cylinder and rotor. The thrust is partially carried by the dummy piston and partially by a Kingsbury thrust bearing. By means of a worm and wheel on the thrust bearing the rotor can be moved axially to change the axial clearance of the dummy strips to any desired valve. The cylinder is split on a horizontal plane

chest integral with the cylinder similar to the main or high pressure chest. This type of construction is used because of the high bleeder pressure, the use of the grid valve construction being at present limited to bleeder pressures of approximately 200 lb. A compensated bleeder regulator, receiving its impulse from the 400 lb. bleeder line, controls the admission valves in the bleeder chest. These valves control the flow of steam from the bleeder zone into a nozzle chamber which is divided into six sections corresponding to the six valves. Each section of the nozzle chamber supplies steam to a nozzle group, through which the steam expands then passes through a single velocity impulse stage, and onto the second reaction element, which expands the steam to the exhaust pressure of 140 lb.

Blading and Clearances

Since for most operating conditions, that section of the turbine preceding the bleeder zone produces most of the kilowatts generated, it is desirable to make this section as efficient as practicable. With the high steam pressures existing in this section, the total volume of the steam is correspondingly small, resulting in small areas. In order to reduce to a minimum the amount of steam which passes through the clearance area and does no work, this high pressure blading may be shrouded to advantage. The cylinder and rotor carry radial sealing strips which can be run at smaller clearances than the ordinary unshrouded blade since the sealing strips (Fig. 3) are of special material and light construction which will wear away in case of accidental contact, and which are easily replaced. All reaction blading has the T-root fastenings and together with the nozzles are made of stainless steel. The nozzles, as shown in Fig. 4, are of the built-up type in which the passages can be accurately machined, thereby reducing friction losses to a minimum. The seal at the diaphragm of the bleeder chest is effected by radial seals consisting of thin flat strips of molybdenum steel held in the rotor by soft steel caulking strips which are rolled into the grooves. The construction is identical to that used on the seal strips for the high pressure blading. The strips are held in the rotor so that in event of accidental rubbing, contact will not be made on the rotor body and heat so generated will be carried off in the stationary element.

Thrust of the rotor toward the coupling end, caused by pressure drop across the reaction blading, is partly balanced by the dummy piston and the remainder is carried by a Kingsbury thrust bearing. The clearance between the dummy seal strips and corresponding rotor lands is an axial rather than a radial clearance. By means of a worm and wheel on the Kingsbury thrust bearing, the rotor can be moved axially, thereby changing the axial clearance of the dummy strips to any desired value.

Glands (Fig. 5) are of the combination labyrinth and water seal type. The labyrinth at the thrust end is of the axial clearance type similar to the dummy while the coupling end labyrinth is of the radial type sim-

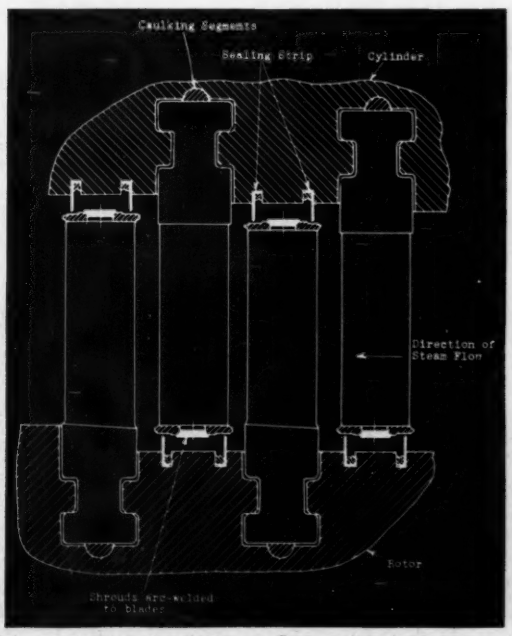


Fig. 3. The high pressure blading is shrouded and sealing strips used to reduce blade clearance

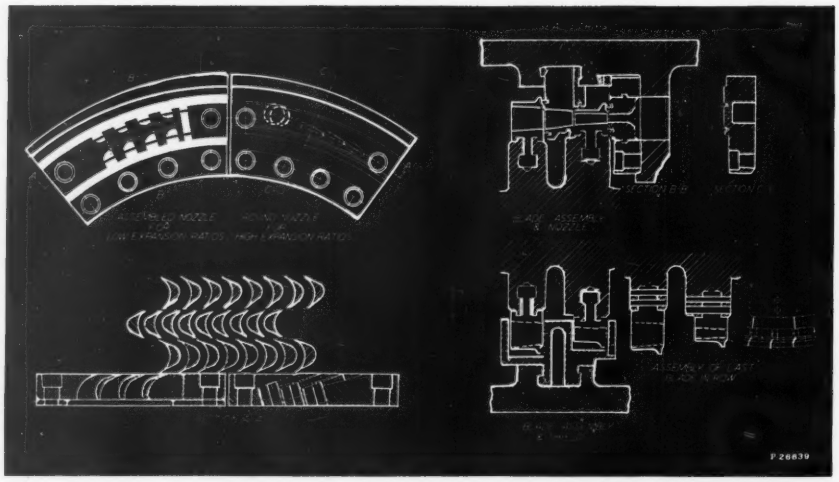


Fig. 4. Nozzles are of the built up type in which passages may be accurately machined to reduce friction losses. Thin flat strips of molybdenum steel held in the rotor by soft steel caulking rolled into the grooves are used to seal the diaphragm of the bleeder chest. In case of accidental rubbing the easily replaced strips wear away without causing damage. All reaction blading has the T-root fastenings and like the nozzles are made of stainless steel.

ilar to the bleeder diaphragm seal. The gland case is supported on the bearing housing and is connected to the hot cylinder wall by a flexible diaphragm. This arrangement reduces to a minimum any gland distortion which might be caused by the extreme temperature gradient between it and the hot cylinder. As shown in the illustration, the gland case also carries the oil seals for the pedestals. A stainless steel liner is provided in the gland case and separate stainless steel sleeves are provided on the rotor to protect the gland case and the shaft adjacent to the runner against erosion.

Supports

The cylinder is split on a horizontal plane through the axis so as to form a cylinder base and cover. The reaction blading is carried in two separate blade rings obtaining a design resulting in symmetrical movements caused by thermal changes, and thereby reducing to a minimum the possibility of distortion. As can be seen in Fig. 2, the result is a symmetrical cylinder with no extreme temperature gradients in the blade carrying elements.

This cylinder is supported by four arms which are cast integrally at the top of the base, thus locating the point of support as closely as possible to the horizontal centerline. These arms rest on pedestals which are separate from the cylinder, thereby allowing these carrying elements, to remain relatively cool. At the coupling end, these arms are bolted to the pedestal in such a manner as to allow transverse expansion but anchor the turbine in a longitudinal direction. The pedestal carries a single vertical key on the longitudinal centerline engaging the cylinder base and thus maintaining correct transverse position but allowing vertical expansion. The arrangement at the thrust end is identical to the coupling end except that while the coupling end pedestal is bolted solidly to the foundation, the thrust end pedestal is free to slide on a separate base, thus providing for longitudinal expansion.

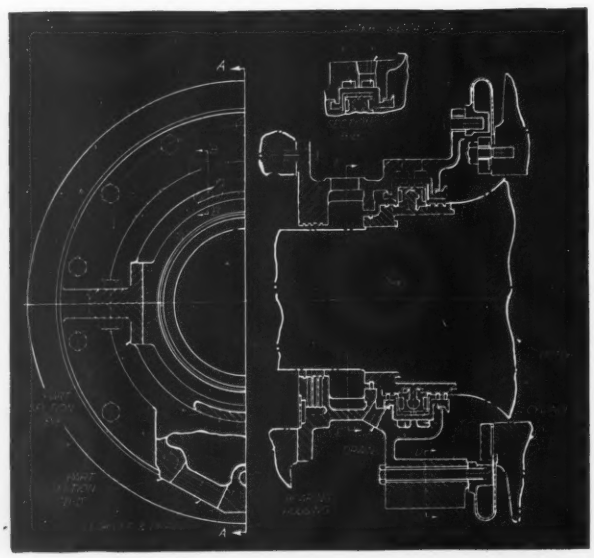


Fig. 5. A combination of labyrinth and water seals are used for the glands

Governing

Main governor consists of a double oil impeller mounted on the thrust end of the rotor. The speed-responsiveness of this governor results from the fact that the changes in speed vary the impeller discharge pressure. High pressure oil for the operating mechanism of both the main and bleeder steam chests is furnished by the impeller, while oil for the bearings and impeller suction is furnished by an ejector on the oil reservoir. The oil reservoir is separately mounted and contains a submerged turbine driven auxiliary oil pump. The unit is provided with a compensated bleeder regulator which maintains bleeder pressure and frequency.

Exhaust pressure is maintained by means external to the turbine. The header to which the exhaust steam is supplied is also supplied by a battery of low pressure boilers. The pressure in this header is therefore maintained by these low pressure boilers since they supply whatever 140 lb. steam is required over and above that obtained from the turbine exhaust. In event of excess pressure in this header, steam is blown to the atmosphere through relief valves.

Readers' Conference

Limited Storage Space for Fuel

IT IS OFTEN the case that the individual industrial venture which has proved to be successful finds itself more or less severely afflicted by a lack of space. Limited capital or other factors in the beginning, preclude the possibility of providing extra space to take care of future expansion, and many times everything possible must be done to conserve and make the most of every bit of available space.

In cases of this nature, the power plant may be crowded into a rather small space, and the provision of ample space for fuel storage may be a serious problem. In this connection, it is interesting to note that a change from coal to oil burning may be the means of saving considerable space. Not only is it possible to store three units of heating value in oil where only two in coal can be stored, but the storage space for the oil may be at a point further removed; thus, a storage point which is of little value for other purposes may be taken for the oil, thus redeeming an out-of-the-way corner or space. Getting the oil to the boiler is seldom a major problem, for if located high, gravity will do the trick, and a pump will do it in any case. It is one of the points in space conservation that may well be considered with care.

Peoria, Ill. JOHN E. HYLER.

Power Plant Fires

A SERIOUS power station fire occurred in a Brussels power station due to some leakage oil becoming ignited, probably due to a short circuit in a small motor operating the speed control gear of a large turbine. The turbine casing had accumulations of seepage oil on it and this together with other inflammable material in the vicinity caused a conflagration. A screwed plug in the lubricating oil system then blew out permitting more oil to escape, making the fire worse.

Accidental fires of this kind are always liable to occur in any plant, but if there is no leakage oil in the plant and a minimum of inflammable material about, these fires will not spread and will be more or less localized. Any oil leaks from any bearings or oil pipes should be immediately repaired, and any leakage oil kept wiped up. Inflammable material and cleaning rags should be kept away from hot equipment. Woodwork should be avoided for any construction work in the vicinity of plant, but if the use of wood is unavoidable it should be treated with some fire resistant solution which will reduce its inflammability.

There is also the possibility of oil dripping on hot steam pipes, where this is liable to occur, the steam pipes should be screened with asbestos sheets. These screens should be placed about 3 in. distant from the steam pipe. Joints and screwed connections in the lubricating oil system should be regularly inspected for signs of loosening and leakage.

Owing to the higher steam temperatures now becoming usual, the risk of leaking lubricating oil becoming ignited is much greater, this makes it necessary to prevent any slight oil leakage and avoid any accumulations of inflammable material.

Kent, England W. E. WARNER.

Ammonia in Laid-up Boiler

REFERRING TO THE article by C. C. Custer on the above subject in the September number of Power Plant Engineering, I dare say there is considerable truth in what Mr. Custer says, but fear he is inclined to somewhat exaggerate the dangers that are inherent in ammonia.

There are thousands of plants in the world in which ammonia is used, and that ammonia is in constant contact with wrought iron and cast iron in all variations of thickness and quality, and we seldom hear of leaks such as described by Mr. Custer. One would think on reading Mr. Custer's article that ammonia will just about eat its way through anything, and that it is very fond of all sorts of impurities.

Take, for example, the first rule which Mr. Custer states is a U. S. Navy Safety rule: "Ammonia in its gaseous state is spontaneously inflammable". Holy smoke! That sounds *bad*. Here we have been using ammonia for years and years and have known it to leak out into the atmosphere, and even come in contact with open flames without giving any trouble whatever. In fact if you turned ammonia gas onto a burning flame the ammonia will be more likely to extinguish the flame than to burn. And here, in spite of that, the U. S. Navy says that ammonia gas is "spontaneously inflammable".

It is true that ammonia gas is inflammable under laboratory conditions, which means that conditions must be just right or it will not burn.

However, there may be a little truth in what Mr. Custer says, so let's start at the beginning with a new suggestion. How about shoveling some dry ice into the boiler sufficient to more than fill the boiler with CO_2, which gas I believe Mr. Custer will agree is less destructive than ammonia, and so far as I know, it does not oxidize.

Newark, N. J. W. F. SCHAPHORST.

Boiler Plate Wastage

AN ARTICLE appeared in the Readers' Conference section, July Power Plant Engineering, entitled "Boiler Plate Wastage". This refers to wastage of boiler plate by impingement of solids in the soot blower system. I have read this article with interest, and believe that a few constructive comments are in order.

While some effects may be noticeable when such

solids impinge on a boiler tube, the greatest erosive deterioration is the result of ordinary particles of soot and fly ash picked up by the steam or air jets. These jets attain a high velocity and, when including such particles, have a similar action to sand blasting. One plant having 400 lb. water tube boilers lost six tubes in six months from this impinging of jets.

There is, however, a definite cause and cure for this trouble. The erosive power of a jet drops rapidly on increasing distance to the target (boiler tubes). A properly adjusted soot blower element blows between the boiler tubes of the nearest row. Erosive action of the jet, striking the nearest row of tubes at a tangent, and more directly on the second row of tubes, is at a minimum. The soot blower element is held centered in this longitudinal position, usually by an adjustable steel collar. If this collar becomes loose, the element is allowed to slip along a longitudinal axis, until in some cases, its jets impinge directly on the nearest row of tubes. Rapid erosion then results.

Obviously the preventive is part of the regular inspection program. Often the regular boiler inspector notices this and reports it. It is well for one of the plant personnel, familiar with this work, to include such inspection in the usual preventive, maintenance systems, and for the repair department to keep the soot blower elements centered securely in the proper position.

Flushing, N. Y. HARRY M. SPRING

I HAVE BEEN interested in a recent article by J. O. G. Gibbons entitled "Oil Burners for Power Boilers." Everyone is fully entitled to an opinion but, where those engineers foregather who have actually operated oil burners of both types under all conditions, the general favor is usually for the mechanical type. Just to mention one reason, viz. starting up from cold where there is no steam available at all. With the mechanical burner, this presents no obstacle and steam is quickly raised.

The matter of tips blocking up is so trivial as to be negligible as an argument either pro or con. If the installation has been intelligently laid out there are, or should be, several burners operating under each boiler. Not only is this advantageous for the economical carrying of various loads but it permits of burners being changed at regular intervals with no loss of output. Changing a burner is such a simple job and takes less than a minute in actual time. The cost and trouble of cleaning tips and strainers is absolutely nil so there is very little excuse for clogged burners at any time. Wide range operating can most certainly be obtained if there is more than one burner in the furnace, in fact, with intelligent use of various size tips, found out by experience, it is possible to carry any load, at all times, with high oil pressure without dribbling, clogging, carbonizing or poor atomization.

The burner tips should be made with a curved nose extending in front of the nut so that a rod may be passed over the face when necessary to check any tendency to choke up.

To advance, as a favorable argument for the steam atomizing type, the fact that low pressure oil will not require high pressure fittings is being meticulous in the extreme sense. Considering that the life of the installation will be, at least, 10 yr. surely the saving of a few dollars in this respect is not important. Further, oil lines and fittings of the small size usually used for this work are not required to be of extra heavy construction.

While the article criticized here states that the steam required for atomization will be less for the steam atomized burner than with the mechanical type, attention should be drawn to the fact that this is the opinion of the author only and unsupported by factual evidence. Under the most favorable conditions, in large carefully supervised plants, steam for atomization and pumping may average 2½ to 3 per cent, but as a general average of all plants I believe 4 to 5 per cent would be a more correct figure, 2 per cent is approaching the millenium for practical purposes although, in the sales talk prior to purchase, I admit that it sounds splendid.

The author is, as stated, entitled to his opinion on this point but I believe he will find that the carefully tabulated reports of the N.E.L.A. contradict him and prove that mechanical atomization requires less steam than the steam atomized installation.

Rutherford, N. J. MARK BELL.

What Are Harmonics?

Q. I HAVE several questions that I would like to have answered. What are harmonics and how is their presence determined?

Are they produced in generation or transmission?

What action have harmonics on an alternator?

Are harmonics the same in two alternators in parallel?

Will harmonics cause the windings of an induction motor to be punctured?

Is the third harmonic more detrimental to an alternator than harmonics of higher frequency?

Seattle, Wash. F. ORNER.

A. The term "harmonics" as used in alternating current practice refers to currents whose frequencies are multiples of the frequency of the main current in a circuit. In this sense, the term has exactly the same significance that it has in music. For example, middle C on the piano (or any instrument for that matter), has a frequency of 256 vibrations or cycles per second; C one octave higher than middle C has a frequency of 512 cycles per second, exactly double that of middle C. Thus this tone, one octave above middle C, is said to be the second "harmonic" of middle C. Exactly the same thing is true for alternating currents. If 60 cycles is taken as the fundamental frequency, 120 cycles would be its second harmonic and 180 cycles its third harmonic.

Now, it is a well known law of physics and music also that a single vibrating string can vibrate at both its fundamental frequency and one or more harmonics at the same time. The harmonics, of course, are not as strong as the fundamental but they exist nevertheless, indeed, it is due to the harmonics that the tones of different instruments have different characteristics. Usually in this connection they are called overtones.

Similarly, in electrical circuits. harmonics of the fundamental frequency may exist at the same time. This does not mean that there are a number of entirely separate currents flowing at the same time. There can be only one current at one time but that current may

be considered as the resultant of several different currents acting at the same time.

In other words, all periodic waves may be resolved into sine components of various frequencies. The frequencies of these various components are exact multiples of that of the resultant complex wave, the first (and usually the chief) component having the same frequency as the resultant wave. This component is called the fundamental. This is shown in Fig. 1. Here we have a fundamental at "A" and the third harmonic at "B." By adding these two curves together we get the resultant "C" which is really the only current in the circuit.

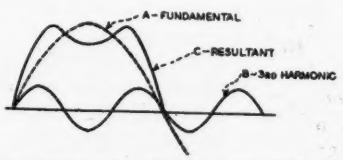


Fig. 1. Fundamental "A" and a third harmonic "B" added together to produce resultant, "C"

From this illustration it should be apparent that any irregular wave can be resolved into its sine components, i.e., a fundamental and a number of harmonics. The fundamental is called the first harmonic. This method of resolving a complex periodic wave into its components is called harmonic analysis. This is accomplished either mathematically, graphically or by special electrical or mechanical devices called harmonic analyzers. Fourier's theorem states that any continuous, single-valued periodic function may be split up into series of simple sine functions, this being true, however complex the original function. The mathematical theory involved is too complex to outline here but if it is understood that each sine component can be represented by a relatively simple term and that the Fourier series is the sum of all these terms, the general principles involved should be apparent. While there may be an infinite number of terms in this series, in practice only a limited number are, of necessity, considered, the analysis being more nearly accurate the greater the number of terms included.

Harmonics are produced in any electrical circuit depending upon conditions, i.e., upon the natural frequency of the circuits, upon the linearity or non-linearity of the circuit, or upon extraneous disturbing influences. In modern alternators an endeavor is made to shape the magnetic circuit so that the e.m.f. is a pure sine wave, nevertheless, a triple harmonic of some magnitude usually exists in the e.m.f. of single phase alternators and in each of the individual phases of a polyphase generator. The e.m.f. between two terminals of a three phase generator, however, does not contain any triple harmonic for the following reasons:

Consider first in Fig. 2 a delta connected three phase generator, in each phase of which is a prominent triple harmonic; a, b, and c represent the three e.m.f.'s displaced 120 deg. It is seen that even though the three e.m.f.'s are displaced, the three triple harmonics are in phase. Thus, the machine is really running under short circuit as far as the triple harmonic is concerned. A triple frequency current will be established which will consume the e.m.f. which, therefore, will not appear in the terminal e.m.f.

The triple harmonic current will, however, set up an armature reaction which will distort the field magnetism and thereby cause a fifth and seventh harmonic. With a star connection, the terminal e.m.f. is the resultant of two e.m.f.'s, OA and OB in Fig. 3. Referring to Fig. 3, we see that OA, OB and OC, the individual e.m.f.'s, are displaced 120 deg. The e.m.f. between A and B is resultant of OA and OB, thus OA—OB (the minus sign on account of direction). In a are given the e.m.f.'s in A, in b are given the e.m.f.'s

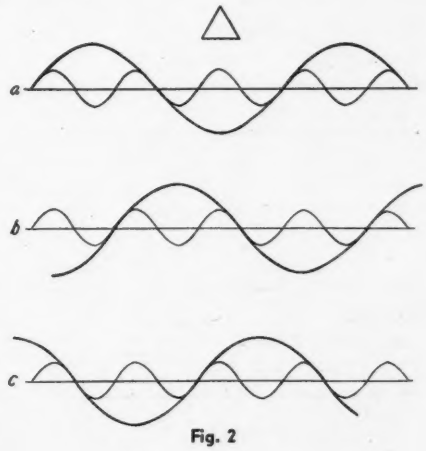
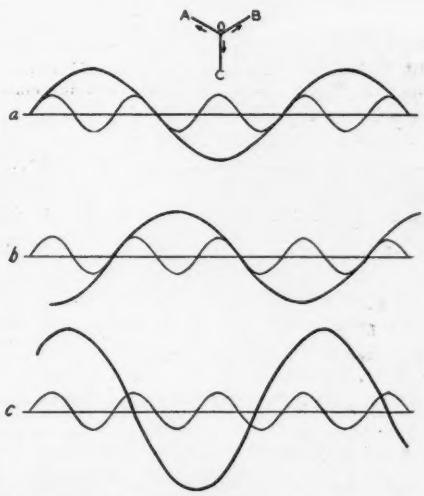


Fig. 2



Figs. 2 and 3. Effect of harmonics in delta and Y connected machines

of OB; and their resultant (with OB reversed) is C. The triple harmonic again has disappeared, but the fundamental is larger than in the individual phase. In the e.m.f. against the neutral or ground, the triple harmonic exists; therefore, the charging current against ground will be of triple frequency and multiples thereof, if permitted to exist, that is, if the generator neutral is grounded.

Transformers are a source of triple harmonic e.m.f.'s or currents, but this can also be eliminated if one side of the transformer is delta-connected, as should usually be the case.

In general, it can be said that the triple harmonics should give no difficulties in a three phase circuit; it need not exist.

The distortion caused by harmonics in a circuit

depends not only upon the frequency and amplitude but also upon the relative phase displacements between the harmonic and the fundamental. In Figs. 4 and 5 are shown the resultants produced by two third harmonics with the fundamental, one (Fig. 4) displaced 60 deg. and the other (Fig. 5) displaced 0 degrees.

In Fig. 6 is shown the resultant produced by the fundamental and the third and the fifth harmonics, while in Fig. 7 are shown the fundamental sine wave and the complex waves produced by the superimposition of a triple harmonic of 30 per cent of the

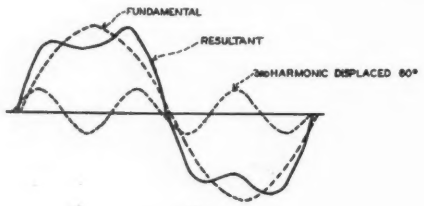
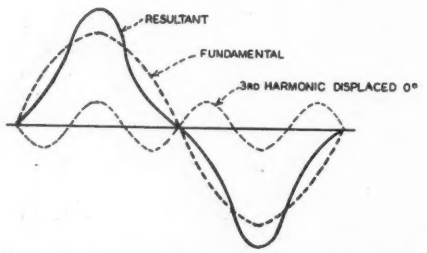


Fig. 4



Figs. 4 and 5. Resultants produced by two third harmonics with the fundamental, one (Fig. 4) displaced 60 deg. and the other (Fig. 5) displaced 0 deg.

amplitude of the fundamental, under the relative phase displacements of 0, 45, 90, 135, and 180 degrees. As seen, the effect of the triple harmonic in the first case is to flatten the zero values and point the maximum values of the wave, giving what is called a peaked wave. With increasing phase displacement of the triple harmonic, the flat zero rises and gradually changes to a second peak, giving ultimately a flat top or even double-peaked wave with a sharp zero. The intermediate positions represent what is called a saw-tooth wave.

The fifth harmonic causes a flat topped or even double peaked wave with flat zero at 0 deg. displacement and as the displacement increases, this wave also becomes of the type called saw-tooth.

In general, from the simple inspection of the wave shape, the existence of these first harmonics can be discovered.

The above is a comparatively simple outline of the

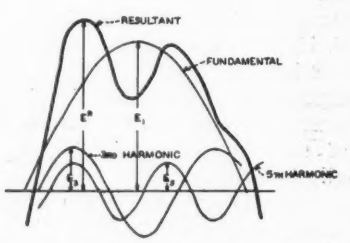


Fig. 6. Resultant produced by combining the fundamental and the third and fifth harmonics

principles and theory of harmonics. The subject can be made as involved as desired, in fact it constitutes a special branch of electrical engineering. Harmonics produce various effects in alternating current circuits which may or may not be harmful depending upon circumstances. In some cases they produce circulating currents. In three phase systems they cause what are known as oscillating neutrals. In the production of sharply peaked voltages the insulation of the system may be subjected to undue strain with consequent failure. Their cause involves a detailed study of magnetic and electric circuits, for in many instances the source of the harmonic lies in the magnetic characteristics of the iron.

This is particularly true in the case of circulating currents caused by harmonics in closed delta circuits. In this case the magnitude of the circulating current depends upon the resultant third harmonic e.m.f. and the total impedance of the closed delta. The value of the third harmonic e.m.f. in this case is a function of the characteristics of the iron cores in the choke coils and the degree of saturation being the greater the greater the divergence of the BH curve from the initial straight line.

In general, the greater the degree of saturation the greater the magnitude of the third harmonic e.m.f.

You ask whether the third harmonic is more detrimental to an alternator than harmonics of a higher frequency. The answer to this is no. The effect of harmonics is not so much a function of the frequency of the harmonic, that is whether it is the second, third, fifth, seventh, or ninth, but as is probably evident from the foregoing explanation, more upon the amplitude and phase displacement with respect to the funda-

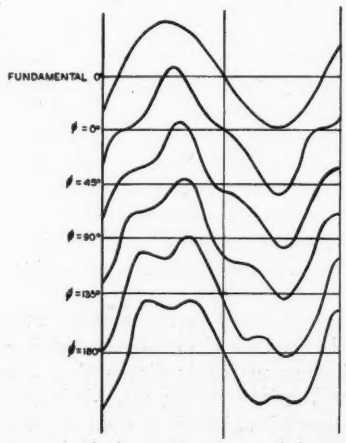


Fig. 7. Fundamental sine wave and complex waves produced by the super-imposition of a 30 per cent triple harmonic under relative phase displacements of 0, 45, 90, 135 and 180 deg.

mental. As has been shown, the phase displacement of a particular harmonic determines whether the resultant has a flat or peaked characteristic and naturally a sharply peaked characteristic would subject the insulation of a particular circuit to greater stress than a wave with a flatter characteristic. The phase of a harmonic exerts a profound influence upon the shape of the resultant complex wave. The same harmonic may produce a peaking effect, or it may do just the reverse and give rise to a dimpled wave.

New Equipment

Super-Silvertop No. 10

SUPER-SILVERTOP No. 10 trap is designed so that now more than ever, the smaller steam-using units can be individually trapped. This new trap, a product of V. D. Anderson Co., 1939 West 96th St., Cleveland, O., is ideally suited for use at drip points on steam mains and on any other type of steam heated equipment requiring a small trap.

It has practically all the features of the larger Super-Silvertop traps. Valve and seat are made of Anderloy, a hard, chrome

alloy. Bucket is made of one piece copper and all working parts of stainless steel. The bucket is guided by the hexagonal tube used on the larger sizes of traps. It operates on vacuum. No strainer is necessary since it handles ordinary dirt and scale. Super-Silvertop No. 10 can be inspected, cleaned or disassembled without removing the trap from the line. The head is held in place by stainless steel screws. Pipe connections are like those on thermostatic traps, permitting replacement of the thermostatic traps without changing the piping. Super-Silvertop No. 10 can be fitted with the Anderson Thermal Air Eliminator.

Coulee Dam Conveyor Belts Salvaged

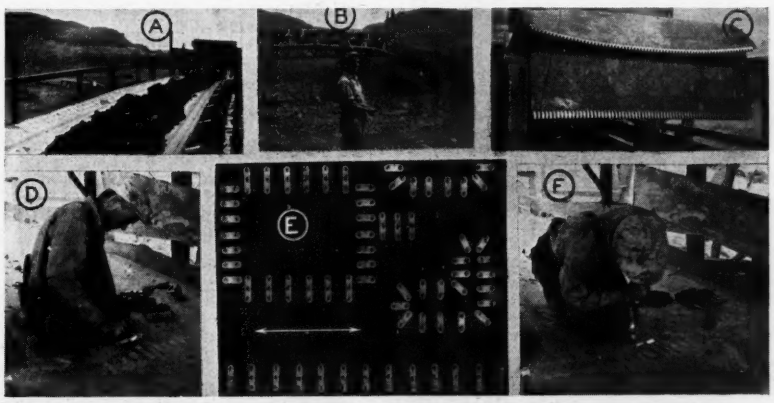
DRIVING AT NIGHT, because it's so hot there in August that water is run over roofs to cool the house—and even the flies have moved north, one rounds a curve on the vast desert plateau and far below is a vast pool of light, flanked by a town on either side and split by the black Columbia River. The Grand Coulee project. Where 5000 men are working in three shifts. Part of their task is to move a mountain a mile and dump it in Rattlesnake Canyon; where a mile-long conveyor in 22 sections, see Fig. A, delivers, in 21 hr., up to 50,000 cu. yds. of earth and of rock 16 in. diam. and under, elevating it 325 ft. before it reaches the dump.

From one belt section to the next, drops of 5 to 9 ft. are somewhat broken by swinging hooks, but wear is heavy and rips are frequent. And so Superintendent John Cunning, seen in view B, worked out a new use for Flexco HD steel belt fasteners, even a new design of fastener, to save the conevyor belt, which costs upward of $10 a ft., rather than junk it. When the dropping rocks have beaten holes or soft places in the belt, rips are "sewed up" with fasteners as shown in Fig. E and at the left in Fig. A, or patches are inserted as in Fig. E. For a crosswise tear or a patch joint across the belt, the two-bolt fasteners are used, placed close together. Patches which are rectangular or L shaped, as diagonal patches don't stand up, have the corners rounded, so that a fastener can be set angling. For long longitudinal rips or joints, two fasteners were at first used with three bolts, the center bolt being in the seam, in order to give better grip of the fasteners against cross strains in the belt. Plates were spaced some 3 in. apart. The 3-bolt fastener plate was developed by the manufacturers, Flexible Steel Lacing Co. of Chicago, to avoid the inconvenience of overlapping ends, see lower seam in Fig. E. For pulleys over 5 ft. diam., the 3-bolt fasteners can be used on both lengthwise and cross seams; for smaller pulleys, they should be used only on lengthwise seams.

Three times a day, at the stops after shifts, the belts are gone over for repairs. Every spot that looks suspicious is pounded and, where needed, reenforced by fasteners. A special hollow hook is used to fish the bolts through the plates as in Fig. D, then nuts are screwed home as in Fig. F. The belts contain thousands of fasteners, eight of them having been ripped from end to end, patched and now working perfectly.

All belts but one have the joints made with fasteners. The exception is the section that is lengthened when the stacker in Fig. B is advanced. This has 17 joints of No. 75 Alligator steel belt lacing with hinge pins. Above this section a 100-ft. length of belt with lacing on the ends, Fig. C, is kept ready. When tension is released, a hinge pin is pulled and the new section inserted with hinge pins at the ends, the stacker i moved forward and work goes on, the operation taking only 28 min., as Mr. Cunning says, the most rapid method of advancing a stacker that he has found in 10 yr. experience, and an element of prime importance when 1200 to 2500 cu. yd. of material are being dumped per hour, at so much per cubic yard. Repairs are also quickly made with the fasteners by any of the men in an emergency, as any one of them can make a repair after being once shown the method.

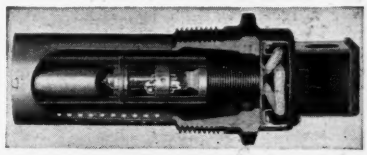
So in moving the mountain at Grand Coulee, thousands of feet of belting have been saved for the contractors, Mason, Walsh, Atkinson, Kier Co., as well as a great saving in shutdown time for repairs and replacements.



A.—Section of mile-long conveyor, showing repair of rip and drop between sections. B.—Superintendent Cunning at the stacker end. C.—Belt ready for insertion to lengthen stacker section. D.—Fishing the bolts through a fastener plate. E.—Patches, and repairs of rips. F.—Setting home the fastener-bolt nuts.

Float Operated Switch

A SIMPLE FLOAT-operated switch for the checking or control of liquid levels has recently been developed by McDonnell & Miller, Wrigley Building, Chicago. The working mechanism, as shown by the accompanying cut-away view, consists of a mercury switch inside of the float which is attached to the head by means of a flexible



metallic bellows. As the float switch moves through its arc, the mercury switch makes and breaks contact.

The unit shown in the illustration can be screwed in a horizontal position directly into a tank or vat, and at any desired height. When the liquid level reaches a height that will move the float, the mercury switch makes contact to sound an alarm, light a warning light, or may be used to start up a motor operated pump or other electrical device. It may also be installed at a pre-determined low level to cut in a motor-pump unit or sound an alarm, as required.

Portable Drawing Board

THE "PRETTY NEAT" drawing board illustrated herewith weighs less than one pound and being only one quarter of an inch thick, takes up very little room in the brief case. Although compact it is extremely efficient, simple to operate, and complete in detail, requiring no thumb tacks or "T" square.

This board which is made by H. E. Twomley, 7154 Magnolia Ave., Riverside, California, is not a toy but is accurately, handsomely and sturdily built of strong material for every day hard usage by en-

gineers, draftsmen, contractors, salesmen, designers, artists, mechanics, students, inventors, and patent attorneys.

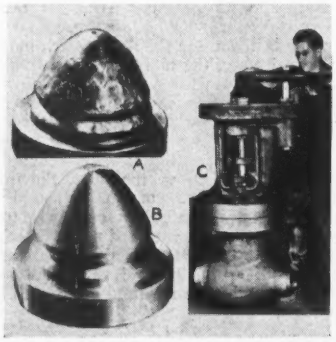
The success of this drawing board is due to the fact that the ends of the triangle guide strips which form the border of the board, and the spring paper clamps are so formed that they elevate the corners of the triangle above the adjacent side, giving absolute freedom of movement of the triangle beyond the limits of the drawing board.

The spring paper clamps are lifted by pressure of the forefinger on small buttons provided on the back of the board.

These drawing boards are accurately made within reasonable limits and extremely accurate drawings can be made on them when accurate triangles are used.

High-Pressure Feedwater Control Valve

To HANDLE feedwater under 1500 lb. per sq. in. pressure requires valves carefully designed and of selected materials. For a recent 1400-lb. installation, bodies of 6-in. globe valves were specified to stand 3500 lb. hydrostatic pressure, yet design was such that, with a 50-lb. disc, the valves could easily be manually operated. To ensure economy in operation and



obviate replacements of discs and seats, surfaces were hard faced with Haynes Stellite Co.'s cobalt-chromium-tungsten alloy, bodies of the discs being forged from 13 per cent chromium steel. Parabolic contour was used to give equal increments of flow for equal movement of the hand wheel. This alloy is being used for surfacing all types of gate, globe, angle, non-return, blowoff and regulating valves where conditions require freedom from cutting and seizing and resistance to corrosion. The feedwater control valves mentioned were made by The Edward Valve & Mfg. Co., Inc.

New Type Fuse Clip

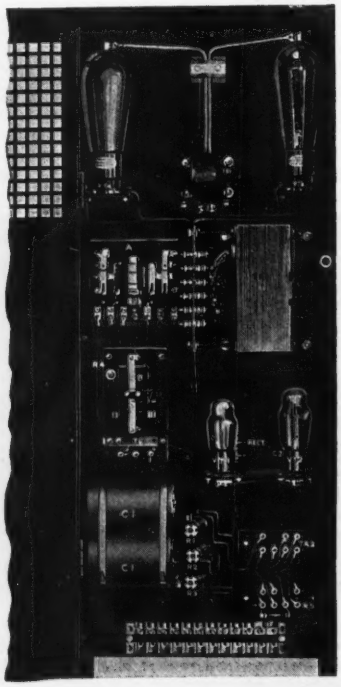
IDEAL COMMUTATOR DRESSER Co., 1033 Park Ave., Sycamore, Illinois, have recently developed a new type fuse clip. In this clip a steel clamping ring is forced over the outside of the jaws, exerting

tremendous pressure against the fuse or switch clips. This is done simply by turning a knob. It takes an equally firm grip on all clips, irrespective of width. The knob is a feature in itself as it has a knurled exterior to give a non-slip grip for the fingers.

Electronic Voltage Regulator

WARD LEONARD ELECTRIC Co., Mount Vernon, New York, has recently developed and placed on the market a new automatic alternator voltage regulator embodying radically different operating principles from those of the conventional types. These regulators perform the same functions as do other and older types of regulators but the method by which regulation is effected is entirely different in that they incorporate electron tubes as their basis of operation.

Instead of relying upon mechanical movements to close contacts or change pressure electron tubes are used to effect the control action. These regulators, known as the Type EF Regulators are controlled rectifiers, deriving their power from



the A.C. generator and delivering rectified current to the shunt field of the exciter in an amount which is a function of the A.C. generator potential.

With the type EF regulator, speed of response is materially increased, for the field potential is no longer limited by the exciter armature voltage.

Basically, the regulator consists of a single phase, full wave rectifier, the output of which is used to excite the field of the exciter.

Among the advantages claimed for these regulators by the manufacturers are the following: 1. No moving parts used in the regulating elements. 2. No maintenance required. 3. No parts require replacement except the electronic tubes. 4. Simple to adjust at the time of installation. 5. Low initial cost as compared to any other "quick response" regulator. 6. Quick acting—corrective action starts approximately ½ cycle after voltage changes from its normal value. Controls a "separately excited" field with consequent quickened response. 7. Fast recovery of voltage due to "field forcing" action. 8. Minimizes voltage swings. 9. Includes a positive anti-hunting means to meet the time constants of any exciter-generator combination. 10. May be mounted in any out of the way place since no maintenance is required except to change electronic tubes at the end of their life. 11. May be mounted as a section of the switchboard. 12. Automatic protection against any regulator trouble or tube failure by automatically cutting out the regulator and running on the field rheostat control. 13. A means of adjusting the generator voltage plus or minus 5% while the regulator is operating. 14. Needs no more attention than does an incandescent lamp.

G-E Motors of New Design

A NEW DESIGN of riveted-frame squirrel-cage polyphase induction motors, in frame sizes of from 1 to 15 hp. at 1,800 rpm., has recently been placed on the market by the General Electric Co. The new motors, available in a variety of electrical and mechanical modifications, incorporate improvements in stator-coil insulation, frame construction, and other design features.

Co-ordination of design permits the different modifications of motors in the line to be used interchangeably for many types of power supplies and for various applications requiring open, sleeve- or ball-bearing, enclosed, enclosed fan-cooled, splashproof, vertical motors, etc. As a result of this adaptability, many special requirements may be met with the standard available line.

A new insulation system "built from the inside out" is employed for the stator-coil windings, which are of the random-wound type, with joints at the connections fused instead of soldered. Recently developed insulating materials and processes are utilized, eliminating the need for taping the end windings and producing an insulation assembly with high resistance to moisture and other common deleterious influences, such as mild acids, alkalis, oil, and abrasion.

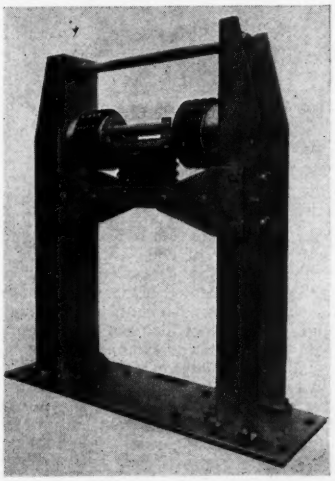
A new riveted-frame construction and new end frames made of malleable iron, with integrally cast feet, contribute to the strength and rigidity of the motors, providing increased resistance to vibrating and shock loads. Cast-iron end shields of ample strength maintain accurate bearing alignment and uniform air gap.

Convenience features include: two-part conduit boxes that provide ready access to leads and can be mounted in any one of

four positions; handy knock-off ledges on end shields, permitting easy disassembly with ordinary tools; adequate wrench room for removing end-shield cap screws; ball bearings provided with pressure grease fitting aud relief plug; sleeve bearings equipped with oil-filler gauge that can be placed on either side of housing; and general simplicity and accessibility of all parts.

High Strength Bus Supports

FOR INSULATING and supporting bus bars in installations where exceptionally high short circuit stresses may occur, the type of bus support shown in the accom-

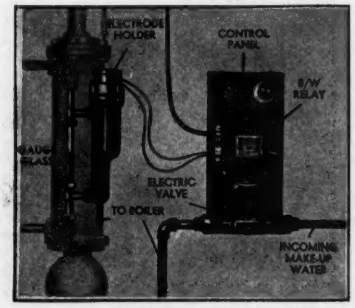


panying illustration has been developed by the Delta-Star Electric Co., Chicago, Ill.

The insulators are interchangeable and the clamps are of the roller type permitting expansion of the bus.

Water Level Control for Small Boilers

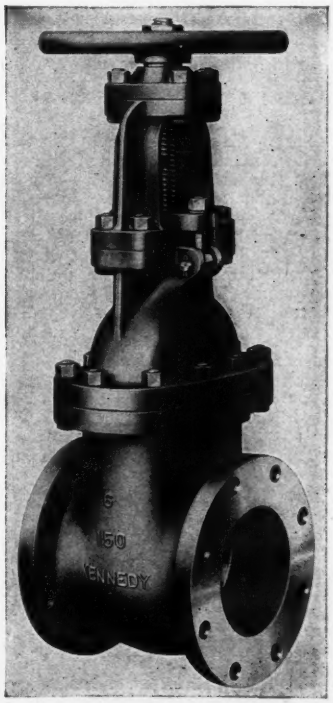
TO MAINTAIN the desired water level in boilers up to 100 hp. and for pressures from 20 to 150 lb., as used for heating and process work, so as to avoid low-water hazard, the Johnson boiler water control has been developed by The Johnson Corp., Three Rivers, Mich. The electrode holder, installed with a gage glass in parallel, in place of the usual gage glass, carries a long and a short electrode. When water level drops below the end of the long one, the relay opens the electric valve and lets make-up water flow to the return trap or pump receiver, until



water rises to contact the end of the short electrode, when the relay closes the electric valve. As is evident, the method is simple and eliminates floats, stuffing boxes, generators and thermostats. Electrodes can be adjusted to different heights so that any desired water level can be maintained.

Kennedy Gate Valves

A NEW LINE of standard iron-body wedge gate valves, which has been developed by The Kennedy Valve Manufacturing Co., has several features which interest engineers and other users of valves. The metal in these valves is of a particularly dense structure, and on test by an outside laboratory has proved to be more than 50 per cent stronger than ordinary cast iron. To further insure strength and rigidity, the bodies are of oval section with well-rounded corners, the flanges and bolts are heavy, and ribbing is provided at the flanges on the larger flanged-end valves and at the yokes and caps of outside-screw-and-yoke valves.



There are no studs at any part of the valves, and all bolts have the nuts above the flanges and with ample room for standard open-end wrenches. In addition to this feature of convenience, both non-rising stem and outside screw-and-yoke types have special provisions to facilitate repacking. For example, the latter type has eye bolts at the stuffing box which swing out of the way, with washer nuts which eliminate the annoyance of loose washers, packing gland with slotted flange bolts, and shelves on the inside of the yoke to hold the gland out of the way. The stuffing-box bolts and nuts are rust-proofed to prevent corrosion.

These valves are made in all standard sizes from 1½ in. to 60 in. for steam working pressures of 150 lb. and water working pressures of 200 lb. Complete description, prices and dimensions may be obtained by addressing The Kennedy Valve Mfg. Co., Elmira, New York.

Pocket-Size Instruments

A COMPLETE new line of pocket-size voltmeters, ammeters, and milliameters, which is designated Type AS-5 and supersedes the Type AS-3, has been announced by the General Electric Company. The new instruments incorporate a new type of element with higher torque and improved characteristics. The over-all dimensions of the standard unit are 5½ by 3½ by 2 in., and the weight is only 12 oz. All the instruments have an accuracy of one per cent of full scale value.

The instruments have magnetic damping, a Permaloy moving vane, and are shielded from stray magnetic fields. All have a knife-edge pointer and a mirror scale for accurate reading. On the double- and triple-scale instruments, a convenient switch on the face makes it possible to change ratings without removing or rewiring terminal connections. The case is of Textolite.

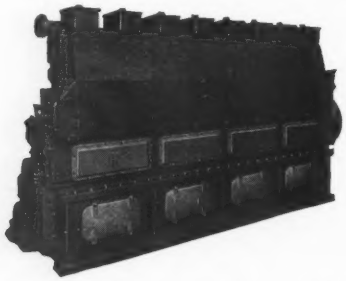
Dewatering Pump

VERTICAL TURBINE PUMPS designed and built specially for dewatering cofferdams, mines, quarries, etc., in capacities up to 10,000 g.p.m. are offered by Worthington Pump & Mach. Corp., Harrison, N. J. They may be used either as portable sinker pumps to be lowered as the water level recedes, or they may be fitted with suitable pipe lengths for fixed installations.

A weatherproof motor at the top, fitted with a vertical hollow shaft, is grease lubricated to prevent leakage in transit or when the pump is not in a vertical position. At the bottom is a galvanized basket strainer which protects the pump from sticks, stones, and other material which might clog. These pumps are rated for total dynamic heads of 20, 30, 40, 50, and 60 feet, the motor sizes varying from 5 to 250 hp., with speeds ranging from 870 to 1750 r. p. m.

Type S Diesel

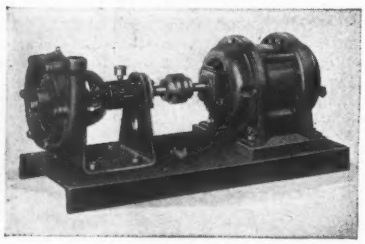
INGERSOLL-RAND Co., 11 Broadway, New York, N. Y., recently announced its Type S Diesel Engine. This engine is of the vertical, four-cycle, single-acting, solid-



injection type designed to run at medium speeds and built for heavy-duty, continuous service. Type S engines are made with 3, 4, 5, 6 and 8 cylinders for ratings from 150 to 460 hp.

Centrifugal Pumps

A SMALL, high-quality, low-cost centrifugal pump is announced by Worthington Pump and Machinery Corporation, Harrison, New Jersey. The utilization of a pressed steel frame combined with quantity production make possible a low cost unit. Simplicity of design results in fewer wearing parts and low maintenance costs. The compactness of the unit makes it

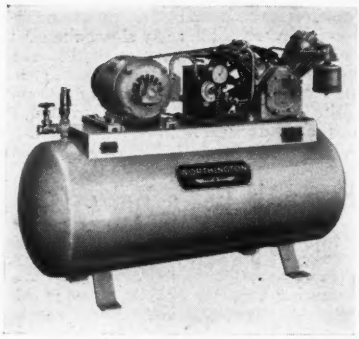


easily adaptable to almost any installation within its head capacity range.

The pumps are furnished with direct motor drives or with pulleys for belt drive. The motor sizes range from one-third to three horsepower, delivering from 10 to 130 g. p. m. with heads from 10 to 100 ft.

Compressor Units

AN IMPROVED LINE of compressor units for garages, repair shops, and service stations is presented by Worthington Pump & Mach. Corp., Harrison, N. J. The single-

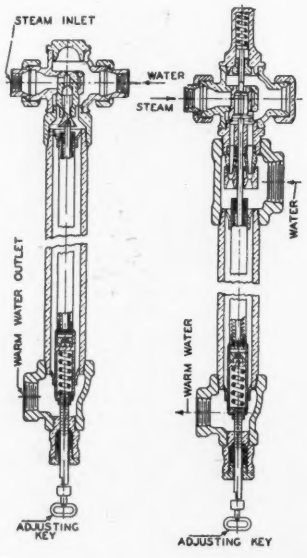


stage units are available with vertical compressors. Motor sizes range from ¼ to 5 hp., with displacements from 1.43 to 24 c.f.m. at a maximum pressure of 150 lb. per sq. in.

Two-stage units are available with angle two-stage compressors. The motor sizes range from ¾ to 10 hp., with displacements from 3.9 to 45 c.f.m. at a maximum pressure of 200 lb. per sq. in.

Steam and Water Mixer

SARCO COMPANY, INC., 183 Madison Avenue, New York, manufacturers of steam specialties, announce the new Sarco Steam and Water Mixer. This compact and self-operated mixing valve produces hot water at any desired temperature automatically, directly at the point of use, by mixing steam and water in the proportions required. In this way the new mixer incorporates a three-way valve, a water injector and a temperature regulator, all

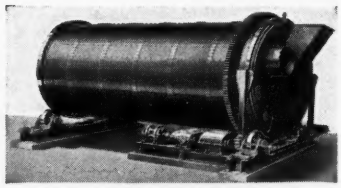


in one compact unit. Nozzle type injectors are used to insure silent operation. Small sizes use single seated valves, large sizes, double seated. These steam and water mixers will be found of great advantage in industries where hot water at different temperatures is required by different departments. Frequently they will make unnecessary, the use of separate small water heaters.

Louvre Dryers

ANNOUNCEMENT is made by Link-Belt Co., 300 W. Pershing Road, Chicago, that it has acquired the manufacturing and sales rights for North America for the Dunford & Elliott rotary louvre dryer.

It is being offered for the drying of all types of granular materials, coarse or fine, or of irregular shape, size and consistency; all types of crystals and powders manufactured or used in the chemical industry; factory refuse and waste; vegetable products, etc. It has also been employed as a heating or cooling unit; as a general reaction vessel; and for evaporating liquids on a solid substance. Among

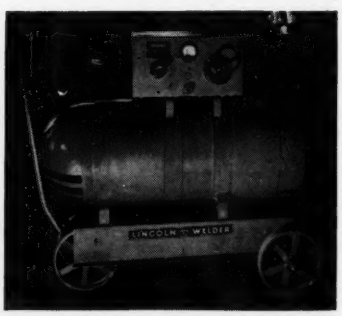


the materials handled are coal, coke, clay, fertilizers, grain, ores, cereals, salt, sand, sugar, wood chips and bark, cement clinker and all manner of chemicals.

The dryer is described briefly as a mechanically rotated horizontal drum with a series of internal channels near the circumference, into which hot air is admitted from a fan. These channels are covered by tangential plates which overlap in such a way as to leave a gap for hot air to pass from the channels into the inside of the drum and into the material contained therein, and at the same time to prevent any materials from falling backwards. The channels are tapered so as to give the inner lining of the drum a gentle slope from the feed end to the discharge end. As the drum revolves, fresh channels come underneath the charge, but, as the hot air can only enter the channels when they are actually underneath the charge, all the gases must pass upwards through the bed of material.

Dual Arc Control Welder

AVAILABLE October 1st is a new line of single-operator arc welders announced by The Lincoln Electric Co., Cleveland, Ohio. These will be known as the Shield Arc SAE, the predominating feature being a new method of arc control which makes possible the adjustment of both arc heat and arc penetration in a continuous sequence of fine increments. It is claimed this continuous dual control gives uniformity of performance at every control setting and adds to successful operation of arc welding, as demonstrated by operation

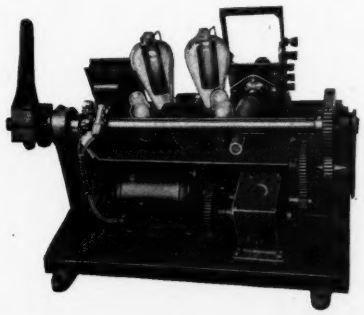


of a large number which have been in actual service in customers' plants for the last year. For certain types of arc welding, low voltage with wide range of current control is desired; for other types higher voltage with the same wide range of current; and the new welder permits the use of correct voltage and current for all classes of work within the range of each size of machine.

Retaining other design points such as independent excitation, laminated magnetic circuit, all purpose meter, polarity reversing switch, no-voltage motor protection, with portable parts redesigned for a shorter wheel base, the new welders are available in a.c., motor-driven, 200, 300, 400 and 600 amp.; d.c., motor-driven, 300, 400 and 600 amp.; generator, belt or direct driven, 200, 300, 400 and 600 amp.; engine-driven, 200, 300 and 400 amp.

Electrically Operated Controller

THE SCHUTTE & KOERTING CO., Philadelphia, Pa., has developed a new electrically operated flow controlled unit for use with its Rotameter flow meter for automatically controlling and proportioning flow rates of liquids or gases. The controller is designed to operate the valves in the fluid stream either directly through motor drives or indirectly through air relay systems.



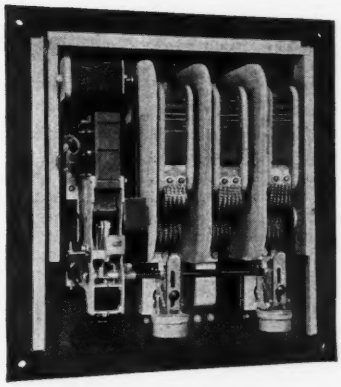
This controller is a new departure insofar as the essential controlling device consists of two grid controlled electronic tubes connected across an induction bridge circuit. Unbalance of the induction bridge by change in rate of flow causes one or the other of the electronic tubes (depending on the direction of unbalance) to be energized and thus energize one portion of a split field valve operating motor so that it runs in the proper direction to restore the flow to the desired value.

Air Circuit Breaker

A NEW AIR CIRCUIT BREAKER, Type AE-1, adapted to industrial and station auxiliary service, or for any heavy duty where many opening and closing operations are required, has been announced by the General Electric Company. The breakers have a 20,000-amp. interrupting rating and are for operation on circuits of 250 v. d. c. and 600 v. a. c. at 15 to 600 amp.

The standard arrangement is an enclosed breaker with pull box for mounting on a wall or behind a switchboard panel; without pull box, for mounting on the front of the switchboard. Main contacts are silver-to-silver; arcing contacts are of special alloy. Double- and triple-pole units are available.

A selective overload feature differentiates between overload and short circuits, time delay being provided up to six to ten times calibration setting and instantaneous above that. The mechanism is electrically operated, trip-free, and latched-in with a solenoid suitable for either a. c. or d. c. depending on rating.



The unit is completely enclosed with the base included within the case. The approximate dimensions with pull box are 19 in. wide, 21 in. high, and 21 in. deep; without pull box, the depth is 9 in.

Improved Thermometers

MERCURY-IN-GLASS Industrial Thermometers have been made easy to read by the Taylor Instrument Companies, Rochester, New York, which employs a uniquely designed thermometer tube.

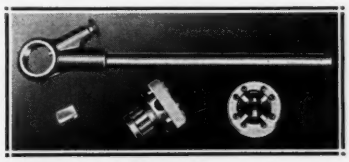
This new thermometer tubing, known as BINOC, has the advantages of more than twice the accustomed angle of vision, combined with high magnification of the mercury column; binocular vision (i.e., readability with both eyes) at normal or

greater than normal distances; triple-lens construction gathers three times as much light and concentrates it behind the mercury column, making the column stand out in sharp relief and confusing empty-bore reflections are eliminated by the scientifically determined lens angle and extended opaque background.

The legibility of these new Taylor Industrial Thermometers is further improved by the bold, black numerals and graduations on the cream-tinted, non-tarnishing scale.

New Beaver Threader

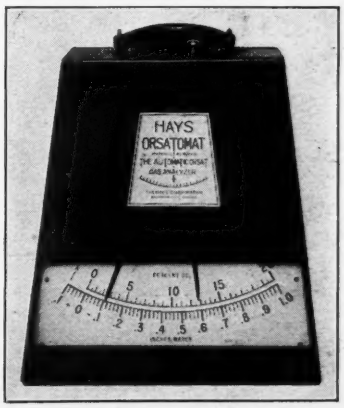
THE NO. 2 BEAVER RATCHET THREADER, shown herewith is a new addition to the Beaver Line, manufactured by Beaver Pipe Tools, Inc., Warren, Ohio. It's an exceptionally fine tool and possessed of many advantages not offered in tools of similar pattern such as oil holes in the



die heads for easy oiling and chip clearance; dies square in shape with no breakable offsets; dies can be inverted for threading close to walls; dies easily removed for resharpening. Further, the tool is made of unbreakable Air Furnace Malleable Iron. The finish is rust-proof. Vanadium alloy steel dies are used.

Automatic Orsat

THE HAYS CORP., Michigan City, Ind., announces the new Hays ORSATOMAT which combines the accuracy of the Orsat principle with a new idea in analyzer design. With the Orsatomat it is easy to analyze a flue gas sample in only twenty seconds by simply moving one lever. The results are plainly indicated by a pointer

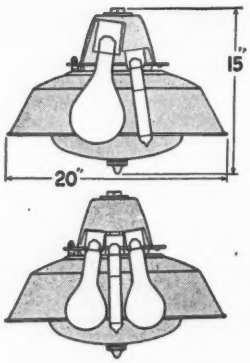


movement on a large legible scale. There are no mechanical valves and no manual measuring or manipulation is required. On the model illustrated, a pointer draft gage is included and space is provided for a flue gas thermometer.

The Orsatomat is available in the standard model for CO_2 and is also available in a twin unit model for analyzing for both CO_2 and O_2. Models with special scales are offered for use in testing automobile exhaust gases.

Lamp Fixtures

BENJAMIN ELECTRIC MFG. CO., Des Plaines, Ill., have recently developed a new line of lighting fixtures and light sources combining the use of both mercury arc and incandescent lamps. These units are especially adapted to the lighting of industrial operations, laboratories, drafting rooms and similar locations. The units shown herewith combine the light from a 250 watt mercury lamp and that of one 300 watt or two 150 watt incandescent lamps. This produces a soft and diffused light which seems to provide an especially high degree of eye comfort and gives a more pleasant light than that provided by either

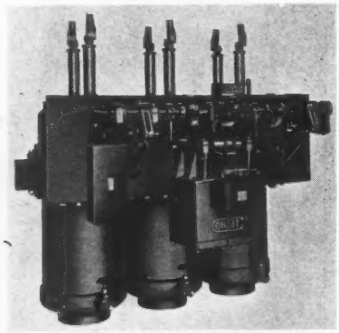


mercury lamps or incandescent lamps alone.

The mixing of the yellow green light of the mercury lamp and the predominantly red rays of the incandescent lamps in this new combination fixture provides a light which is psychologically cool and which simulates sunlight. It is recommended wherever good lighting for better seeing and more accurate work is required.

Oil Circuit Breakers

A NEW LINE of indoor station type oil circuit breakers with interrupting capacity ratings ranging from 500,000 kv-a. to 2,500,000 kv-a. and voltage ratings from 15 kv. to 34.5 kv. has been announced by Condit Electrical Manufacting Corporation, Boston, Mass.



The new line known as type FZ-220 is equipped with Ruptors—interrupting devices which afford quick clearing of short circuits along with low arc energy, low pressure and a minimum of oil deterioration. Other features are: Low inertia high-speed mechanisms; internal oil type shock absorbers; Bakelain bushings; silver-plated contacts, and oil and gas separators.

Contracts Awarded for Seminoe Units

ANNOUNCED AWARD of contracts for two 15,000 horsepower turbines, two governors, and two 12,000 kilovolt-ampere generators for the Seminoe power plant on the Casper-Alcova Federal Reclamation project has been made by the U. S. Department of Interior.

The Pelton Water Wheel Co., of San Francisco, Calif., was awarded the contract for manufacture and delivery of the two turbines on its bid of $100,546.69, and also for the governors, which will be made by the Woodward Governor Co., on its offer to deliver them for $19,233.50. The Allis-Chalmers Manufacturing Co., of Milwaukee, Wis., was awarded the contract for the two generators on its bid of $192,223.22 delivered at Parco, Wyoming. Delivery of the first turbine and generator and both governors must be in 400 calendar days and the second turbine and generator in 430.

The Seminoe Dam and power plant will be located on the North Platte River approximately sixty miles southwest of Casper, Wyoming. The power plant will be located immediately downstream from the dam and is being designed for an initial installation of two 12,000 kv-a. generators and a future installation of a third generating unit of the same capacity. Water for the operation of each turbine will be supplied by a 120-in. diameter penstock through the dam.

New Frick Assistant Sales Manager

FRICK CO. announces the appointment of Clarence C. Smith as Assistant Sales Manager, with headquarters at the Home Office in Waynesboro, Penna. Mr. Smith began his work in this field with the Mechanical Refrigeration Co., of Philadelphia, in 1911 and from that time has been continuously in the refrigerating engineering field, having been associated at different times with C. D. Cooley, Imperial Ice Cream Co. at Clarksburg, W. Va., Frick branch office in Philadelphia and the Oller Engineering Co., which was superseded by the Mack Machine Company of Penna., of which Mr. Smith became president.

He served during the World War in the Naval Ordnance Department. In 1919 he went with the Frid Engineering Company, who were distributors of Frick equipment in Philadelphia.

S. M. Kintner Dies

DR. SAMUEL MONTGOMERY KINTNER, vice president in charge of engineering, of the Westinghouse Electric and Mfg. Co., died at his home in Pittsburgh, Pa., Sept. 28th.

Dr. Kintner was born in New Albany, Indiana, December 11, 1871. He received his early education in the public schools of that city and his technical education at Purdue University, from which he was graduated in 1894 after completing a course in Electrical Engineering.

After spending a year on telephone construction and operation, he accepted the position as assistant to Professor Fessenden at the Western University of Pennsylvania. He continued in this position with Fessenden for approximately two and one-half years and later was made Assistant Professor of Engineering succeeding Professor Fessenden when he left the University. During this period he worked with Fessenden on many investigations on Hertzian waves, x-rays, and other interesting phenomena that were just coming into prominence at that time. He remained Professor for three years and resigned in the summer of 1903 to accept a position with the Westinghouse Electric and Mfg. Co. in their Research Department.

In 1911 he resigned from the Westinghouse Company to become the general manager of the National Signalling Company and then engaged in developing the

inventions in radio of Fessenden. He later became vice president and finally president of that organization or its successor in name.

Following the war he negotiated a sale to the Westinghouse Company of the patent rights of his company, which later were sold by the Westinghouse Company to the Radio Corporation of America.

After spending approximately two years with the Westinghouse Company in assisting them in getting started on their radio developments, he was appointed to the managership of the research department. April 16, 1930, he was elected assistant vice president in charge of engineering activities of the Westinghouse Electric and Manufacturing Company.

NEMA Establishes Welding Development Headquarters

REALIZING the need for cooperative development of the industrial applications of the electric welding process, the Electric Welding Section of the National Electrical Manufacturers Association has established development headquarters in the Frick Building, Pittsburgh, Pa. The welding section has initiated a program of cooperative industry development to investigate the electric welding market and determine the possibilities of extending it. In this program especial attention will be given to application engineering, including (1) the preparation of reliable information on cost savings through the use of electric welding, (2) the preparation of material for the use of and cooperation with construction engineers, designers and architects, and (3) the direct promotion of electric welding by missionary work on important new or undeveloped applications. It has been conservatively estimated that by securing the widest possible adoption of applications which have been definitely successful, the use of electric welding in the metal fabricating industries can be increased at least four fold. Mr. H. S. Card, formerly editor of The Welding Engineer and author of "The Welding Industry," has been appointed Development Director of the N.E.M.A. Electric Welding Section and will be in charge of the Pittsburgh office effective October 1st.

News from the Field

THE BABCOCK & WILCOX TUBE CO., Beaver Falls, Pa., announces changes in its representation in its southwestern sales territory, including: the appointment of H. S. Dershimer as Tulsa, Okla., District Sales Manager, with offices in the Philtower Building, and direct representation in Houston and Dallas, Texas. The Dallas headquarters will be at 728 Wilson Building and business from that area will be handled by Reid R. Lumsden. O. E. Berg will be in charge of The Babcock & Wilcox Tube Co.'s office at 1007 Electric Building, Houston, Texas.

THE GOETZE GASKET & PACKING CO., INC., of New Brunswick, N. J., has just completed another addition to its plant which was originally located on the present site in 1911. This is the fourth addition which has been necessary since 1928. Former capacity has been practically doubled by this added space and through the installation of new equipment including a number of machines of special design.

AT THE COMING National Exposition of Power and Mechanical Engineering to be held in Grand Central Palace, New York City, Nov. 30 to Dec. 5. metallurgical exhibits will be much in evidence. One exhibitor will show seamless steel boiler tubes formed from solid billets by a series of forgings, the process being designed to give the right degree of ductility and strength, to assure easy installation and long service. Other products will include castings of high-strength alloy and carbon steels, also of stainless and heat-resisting alloys. Forging and electric rivet heaters will be demonstrated, with electric eye for temperature control and timing devices for heat treating and hardening.

LEON H. A. WEAVER has accepted a position in the sales and advertising department of The Green Fuel Economizer Co., Beacon, N. Y. He was formerly publicity manager of The Superheater Co., New York.

FEDERAL POWER COMMISSION has denied the application of N. Y., Pa., N. J. Utilities Co. to merge Northern Pennsylvania Power Co. with Metropolitan Edison Co. The last two are operating companies, wholly owned by the holding company. Metropolitan has assets of some $115,000,000 and Northern Penn. some $8,500,000. The proposal was for Metropolitan to pay $2,532,040.19 in cash and bonds to Northern Penn., the latter to be dissolved, when the payment would, of course, go to the holding company. In effect, the commission rules, this would transfer the amount paid from the operating companies to the holding company, with no benefit to the operating companies, hence result in impairment of the position of the operating companies, an effect held to be not to the public interest.

DUE TO ill health, Joseph Davis, executive vice-president of American Locomotive Co., and president of Alco Products, Inc., has resigned. David Dasso has been appointed vice-president—Diesel engine division with headquarters at 30 Church St., New York City, to succeed R. B. McColl who becomes president of Alco Products, Inc., a subsidiary of American Locomotive Co.

REFRIGERATION SERVICE ENGINEERS SOCIETY, an educational organization composed of men serving and installing domestic and small commercial refrigerating equipment, will hold its three-day Annual Convention at the Hotel Gayoso, Memphis, Tenn., November 11 to 13, 1936. Educational program will occupy the afternoon sessions, from 1:30 to 5:30 p. m., when prominent engineers will present papers on the following subjects: Lubricating Oils; First Aid When Overcome by Gas; The Use of Various Neutralizers for Refrigeration Gases When Purging, and the Use of Neutralizers in the System; Unit or Forced Draft Coolers—Where to Use Them and Specific Examples of How to Figure; Conversion of Flat Belt Drives to V-Belt Drives; How to Figure Proper Compressor Capacities for Various Applications; How to Figure a Specified Truck Installation; How to Figure a Specified Air Conditioning Job.

In connection with the convention some forty leading manufacturers of refrigerating equipment, accessories and supplies will exhibit their products. Program of entertainment and visits to points of interest in Memphis will occupy mornings and evenings. National headquarters of the Society are located at 433 N. Waller Avenue, Chicago, H. T. McDermott, National Secretary.

CUTLER-HAMMER, INC., manufacturers of electric control apparatus, Milwaukee, Wis., announce the extension of their manufacturing facilities to the West Coast, where a new plant, at 970 Folsom Street, San Francisco, Cal., recently began manufacture of special control constructions, dead front switchboards, fuse cabinets and panelettes, panel boards, transformer cabinets and wiring troughs under the direction of R. R. Crooke.

DR. THOMAS MIDGLEY, JR. has been elected to receive the Perkin Medal of the Society of Chemical Industry for 1937. The medal is awarded annually for valuable work in applied chemistry and will be presented this year to Dr. Midgley for his work in the development of anti-knock motor fuels, safe refrigerants, etc. This selection is made by a committee representing the five chemical societies in the United States and the presentation medal will be made on January 8 at a meeting to be held at The Chemists' Club, New York.

DEARBORN CHEMICAL CO. is completing an extension to its main manufacturing plant located in the Central Manufacturing District, Chicago. This is the third major addition in a dozen years and gives a 16 per cent increase in floor space, which will be utilized for the installation of new equipment and for a new modern machine shop. The Dearborn Laboratories were also remodeled, and new equipment installed. The Factory offices were remodeled and air conditioned, and the most modern facilities installed for the convenience of employees.

For the Engineer's Library

PRINCIPLES OF HEATING, VENTILATING AND AIR CONDITIONING, by Arthur M. Greene, Jr., 6 by 9 in., cloth, illustrated, 446 pages. John Wiley & Sons, Inc., New York, N. Y., 1936. Price $4.50 net.

Simple, complete, with clear illustrations of plant arrangements and details of apparatus, also illustrative problems on determining sizes of plants and equipment, this book, while designed as a text book, contains data, methods and tabular matter needed by engineer or architect in design. The principles followed are those of the American Society of Heating and Ventilating Engineers, references being given to sources from which data had seen derived.

Ground covered is the Properties and Conditioning of Air, Heat Transmission Through Walls, Calculating Heat for Rooms, Direct and Indirect Steam Heating, Hot Water Heating, Unit Heaters, Warm Air Heating, Furnaces, Boilers and Heaters, Automatic Controls, District Heating. In the appendix are gathered tables on properties of air and steam, heat losses, capacities of heating equipment, fan capacities, sizes of boilers and furnaces.

The standing of the author, who is Professor of Mechanical Engineering at Princeton University, ensures accuracy of the work and effectiveness of presentation of the subject. Conveniently, the answers to problems are given at the back of the book so that the reader can check as to the correctness of his solutions.

THE PROFESSIONAL ENGINEER. By Esther Lucile Brown. 86 pages, 5½ by 8 in. Published by the Russell Sage Foundation, New York, N. Y., 1936. Price 75 cents.

This monograph is one of a proposed series dealing with the present status of certain established or emerging professions in the United States. Although there is a large body of literature on the professions, it is often scattered and sometimes so difficult to obtain that much of it is not used by professional people themselves, and even less of it is known to the laity. In these monographs, therefore, significant data obtained from interviews, questionnaires, books, periodicals and unpublished studies have been assembled and interpreted in such a fashion that it may prove helpful to vocational counselors and those who are striving to make the professions contribute more readily to the welfare both of their members and of society.

DOWTHERM FOR HIGH TEMPERATURE HEAT TRANSFER SYSTEMS. Published by the Dow Chemical Co., Midland, Mich. Size 9 by 12 in., 33 pp., paper bound.

Of recent years Dowtherm has been playing an increasingly important part in industrial methods and processes involving the requirement of controlled heat transfer. It is used in two commercial forms, Dowtherm A, an eutectic mixture of diphenyl and diphenyloxide, which produces a vapor pressure of only 135 lb. per sq. in. gage at the highest recommended service temperature of 750 deg. F. It is developed for and applied to both liquid and vapor heating systems. Dowtherm C consists mainly of the different chemical isomers of triphenyl and small quantities of related high-boiling compounds which serve to reduce its freezing point. It is recommended for liquid systems over a temperature range of 300 to 640 deg. F. but

this temperature limit may be extended to about 800 deg. F. The booklet is a complete treatment of the field of application, servicing of the systems and general notes on the selection and construction of apparatus and contains complete data on the physical and chemical properties of the two materials.

BOILER FEED WATER TREATMENT. By F. J. Matthews. Distributed in America by the Chemical Publishing Co. of N. Y., Inc., 148 Lafayette St., New York City. Size 6 by 9 in., 242 pp., cloth bound. Price $5.

Due to changes in boiler design and operation, the question of feedwater treatment has assumed a position of primary importance and advances made of recent years have been phenominal. As the author has pointed out these advances have been a mixed blessing, for although the large central station, which has a trained chemist, is successfully taken care of, the small plant tends to become confused.

It is from the standpoint of alleviating this confusion and at the same time point out the advances that the author has written this book. Both the author and book are English, yet the natural water supplies, scale formation, corrosion, foaming and priming, analyses and routine testing are the same in this country as in England and the methods of treatment the same. In fact if it were not for a few halftones of commercial equipment referred to by name the origin of the book could not be detected.

The book is divided into the five parts mentioned above and covers not only recent advances but all established water treatment, lime and soda, action of sodium aluminate, zeolite, lime barium, colloidal conditioning, phosphate. A comprehensive appendix gives the standard solutions, reagents, table of hardness and chemical factors involved in boiler feed water chemistry.

MAINTENANCE OF HIGH SPEED DIESEL ENGINES. By Arthur W. Judge, D. Van Nostrand Co., Inc., 250 Fourth Ave., New York City. Size 6 by 9 in., cloth bound, 187 pages. Price $3.50.

During recent years there has been a rapidly increasing use of high speed Diesels and the purpose of this book is clearly defined by the author in the preface. It was written with the object of supplying a comparatively inexpensive but sufficiently complete book to meet the needs of those responsible for engine maintenance and for the user of engines of this type, for automobile, stationary, marine craft. The general information given, however, is to a large extent applicable to other types of Diesel engines.

The major portion of the book deals with practical information of engine adjustments, troubles, fuel pumps, governors, starting and slow running. Throughout the book is well illustrated by sketches and photographs with sufficiently detailed text so that no one with even a limited experience should have difficulty in making the adjustments covered. To facilitate rapid diagnosis of troubles, a fault finding chart is included at the end of the book and a similar chart has been prepared for the chapter on fuel injection systems. These charts give the trouble or symptom, probable cause and suggested remedy.

Illustrations of commercial equipment used are taken from English practice and with the exception of some equipment which is manufactured in both countries, for instance the Cummins engine and the Bosch fuel injection system, the actual engines illustrated differ from American practice. There are a number of excellent books available showing detailed construction of American engines and the omission of these illustrations from this book has no bearing on the general principles set forth and should in no way handicap the American user.

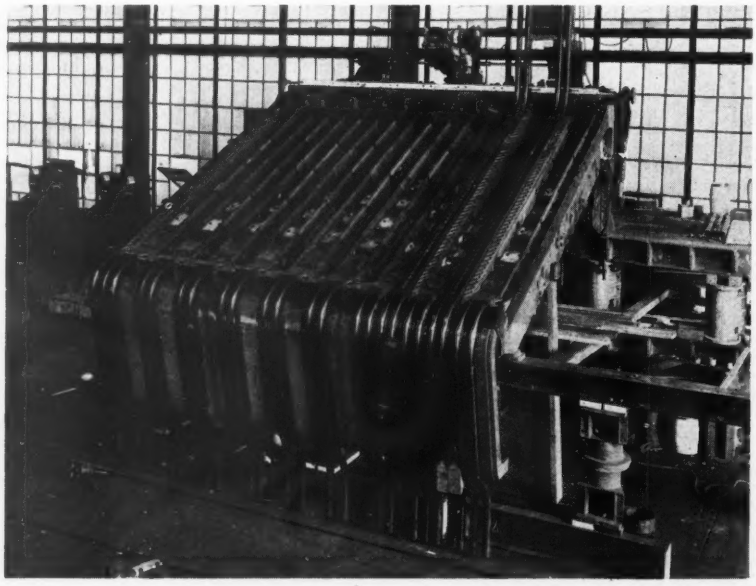
HANDBOOK OF STEAM FLOW MEASUREMENT. By L. K. Spink. Published by The Foxboro Co., Foxboro, Mass. Second edition, size 5 by 8 in., 70 pp., cloth bound.

Orifice type flow meters probably play as important, if not a more important, part in modern industry and industrial control than any single item and this booklet has been prepared specifically for the information and guidance of the user of flow meters. It starts out with a general review of the theory, covers the derivation of formulas, installation, calculation of flow, correction for fluctuating pressures and gives in considerable detail, by curves and tables, the various coefficients and multipliers to be used under different conditions of operation.

THE FOLLOWING BULLETINS have been issued by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Bulletin No. 283, a Study of the Reactions of Various Inorganic and Organic Salts in Preventing Scale in Steam Boilers, by Frederick G. Straub. This is a report of the work carried on by the Engineering Experiment Station in coöperation with the National Aluminate Corp. Price of the Bulletin is $1. Bulletin No. 285, by Cloyde M. Smith and David R. Mitchell, discusses the Possible Recovery of Coal from Waste at Illinois Mines. The price is $0.50. Circular No. 26 covers 11 papers presented at the First Annual Conference on Air Conditioning held at the University May 4 and 5, 1936. The price is $0.50. Reprint No. 7 includes 21 papers presented at the Second Annual Short Course in Coal Utilization held at the University June 11 to 15, 1935. Price $1.

CATHODE RAY OSCILLOGRAPHY. By J. T. MacGregor-Morris and J. A. Henley. First Edition. Cloth. 5½x8¾ in., 262 pages, 151 figures. Instruments Publishing Co., 1117 Wolfendale St., Pittsburgh, Pa. 1936. Price $6.00.

The Cathode Ray Oscillograph is still a comparatively "young" device. It is true it had its birth in the classic work of Crookes and Thomson in the latter quarter of the last century and saw its first application in the field of commercial measurement in the work of Braun in 1897, but it remained a fragile highly scientific plaything until the early "twenties" when it suddenly blossomed into maturity with the general advance in the field of electronics. By virtue of its amazing capabilities it suddenly acquired a position of importance in the field of electrical measurement such as few other devices have ever equalled. For here was a device capable of measuring and recording the highest frequency transients and oscillating currents known to electrical engineers. Through its use lightning left its telltale "fingerprints" for engineers to analyze and classify and finally lead to earth. No speed was too great for it, no phenomena too brief. In its present forms its sensitivity has been raised to



First natural circulation, water cooled Taylor underfeed stoker built by the American Engineering Co. for the new boilers for the City of Rochester, Minnesota. This stoker shown here in partial assembly at the American Engineering Co. shops at Philadelphia is the first of this type ever built. The cooling tubes are tied in with the natural circulation system of the boilers.

such a pitch that it can faithfully record a beam traveling fast enough to cross this page in one ten-millionth of a second.

Small wonder then that this device occupies a most important position in the field of electric measurement and that there is need for a book on it.

Without having read it in detail, the authors seem to have covered the subject very well. Hitherto no book has been published covering the whole range of cathode ray oscillography; consequently it has been necessary for those desiring to gain a knowledge of the subject to read through the quite considerable number of original papers, the majority of which have been published in Germany and the United States.

This book endeavors to present a reasonably concise picture of the entire field of cathode ray oscillography. In its presentation the authors have used their personal experience to select information from all the principal published papers on the subject and no trouble has been spared to render the book international in its outlook. By courtesy of the leading oscillograph manufacturers in Europe and the U. S. A. many detailed drawings and numerical data of actual commercial instruments are included. In this way it is the hope of the authors that the book may be of assistance to engineers interested in oscillograph design as well as to those concerned with the operation and application of these instruments or those who desire general information on one of the most recent developments in electrical engineering.

The book is the second volume of a series of monographs on electrical engineering being issued under the editorship of H. P. Young. The authors are English. Mr. MacGregor-Morris is University Professor of Electrical Engineering, Queen Mary College, University of London.

"ELECTRIC MACHINERY CATECHISM," published by Fairbanks, Morse & Co., is designed to answer those questions that are likely to arise in the minds of individuals who use electrical equipment, and who do not have an extensive formal knowledge of electrical phenomena or terminology. The 48-page volume achieves its purposes remarkably well, through clear, complete discussions, analogies, explanatory drawings and photographs of actual equipment.

The book is divided into four sections: Simple Electric Circuits, Direct-Current Generators and Motors, Alternators and Alternating-Current Motors, and Electrical Machinery in General. These few of the 144 topics discussed indicate the book's scope: What is Electricity? What is Multipolar Machine? What is Meant by Inductance, Capacitance and Impedance? How Does a Synchronous Motor Operate? What Are Slip-ring Motors Used For? What is a Synchronous Converter?

There are over a hundred drawings, photographs and sectional views that show the design of simple machines, the flow and characteristics of electricity, the operation of electrical apparatus, wiring diagrams, etc. An index facilitates use of this book as a handy reference manual.

"Electric Machinery Catechism" is a publication that will find wide use among those who purchase, use or specify electrical equipment. It is an excellent condensed electrical "library" all in itself. Fairbanks, Morse & Co. takes pride in offering it to those many individuals who need to know more about electricity and its application.

THEORY OF LUBRICATION. By Mayo Dyer Hersey. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City. Size 6 by 9 in., 143 pp., cloth bound. Price $2.50.

It is impossible to over-emphasize the importance of this book in the lubrication field. Obviously, the subject cannot be covered completely in 143 short pages but the author has done an excellent job of analyzing and coördinating the extensive and scattered literature on a subject still in the state of flux. The work is divided into six chapters: Historical introduction; Viscosity and its relation to friction; Classical hydrodynamic theory; Dimensional theory, with applications; Temperature rise in bearings; The problem of oiliness. Each chapter is followed by an extensive list of references, for instance 138 after Chapter I, covering a period of from 1699 to 1935.

The author is research associate in engineering at Brown University and the book is based upon a series of lectures given at Brown University in 1934 and repeated at Yale University and M.I.T. in 1935. The lectures aimed to give scientific background of modern lubrication so that practical problems might be better understood. Accordingly, the book is addressed to physicists, engineers, investigators and teachers rather than to the undergraduate student. Due to the condensed treatment and the absence of detail the volume cannot be used as a handbook to which the reader can turn for the solution of a particular problem. As a general summary of the theory of lubrication, however, the book fills a long-felt need and gives to those with a genuine interest in lubrication the fundamental concepts and references where details of specific investigations may be referred to.

HANDBOOK OF ENGINEERING FUNDAMENTALS, O. W. Eshbach, E.E., M.S., Editor-in-Chief, and 40 contributors. John Wiley & Sons, Inc., New York, 1936. 1081 pages; illustrated; 6 by 8 in.; $5.00.

This is the first volume in the proposed new Wiley Engineering Handbook Series which represents a new conception in American handbooks. Mathematics, physics and chemistry, the basis of all engineering, are the fields dealt with in the new volume. "Eshbach" is designed to present in one compact volume a complete summary of the facts pertaining to the fundamental theory underlying engineering practice.

The first section presents a selection of mathematical and physical tables, including new, revised and convenient tables of the American Handbook series on engineering constants, properties of numbers, logarithms, trigonometric and hyperbolic functions; also a series of tables of conversion factors for weights and measures arranged in order of dimensional sequence, tables of integrals, standard structural shapes, and physical properties of metallic and non-metallic materials.

Other sections include: systems of units, standards, fundamentals of theoretical mechanics and mechanics of materials with applications to beams, columns, shafts, and reinforced concrete; the modern theory of fluid mechanics as applied to the fields of hydraulics and aerodynamics; engineering thermodynamics, embodying the latest physical concepts of the fundamentals of heat engineering; the theory of the electric, magnetic and dielectric circuits and their application to generalized networks and transient theory; the fundamental principles of general chemistry, chemical tables and industrial chemistry; the principles of light, acoustics and meteorological phenomena; a concise treatment of the properties of metallic and non-metallic materials with reference to features of manufacture and use; and a discussion of the elementary legal aspects of contractual relations with which all engineers should be familiar.

With readability in mind, the trimmed page has been fixed at 5½ by 8⅜ in., permitting the use of large type, illustrations, and diagrams. The result is an attractive page typographically, and one which reduces eye-fatigue. Regardless of his specialty, every engineer will find here a plentitude of information, presented in convenient form for quick and easy reference.

ALLIS-CHALMERS MFG. CO., Milwaukee, Wis., has released a new leaflet 2230 on their Rocking Contact, Type VI, Voltage Regulators for small alternating current generators. It describes and illustrates this small, moderate cost control unit applicable to various industrial and municipal installations, private and public institutions, apartment buildings, hotels, garages, golf courses, private estates, etc. The regulator described may also be used for many special applications such as speed, current tension regulation, etc.

KEASBEY & MATTISON CO. have recently published a new catalog covering the properties and uses of asbestos and magnesia products. This is a valuable reference book for all who contemplate plant additions, repairs or new construction. It is well illustrated with drawings, diagrams and photographic reproductions of materials and shows a number of special installations.

ALLIS-CHALMERS ELECTRICAL REVIEW is the title of a new quarterly published by the electrical department of Allis-Chalmers Co. This makes its appearance with the September issue, and has a subscription rate of $2.00 per year in the United States, Mexico and Canada. It is an attractive publication containing interesting articles of engineering interest. R. S. Fleshiem, manager of the Allis-Chalmers Electrical Department, is the editor.

A RECENT 6-page circular issued by Durakool, Inc., 1010 North Main street, Elkhart, Indiana, describes their line of mercury switches. These are small, rugged units made with metallic envelopes in sizes from 5 to 200 amps. and for voltages up to 230 v.

TEMPERATURE control for heating or for processing, by means of Brown thermometer controllers is illustrated and described in a leaflet issued by The Brown Instrument Co., Wayne & Roberts Aves., Phila., Pa. Both air-operated and electric control on the Minneapolis-Honeywell systems are included.

DIESEL POWER GENERATING sets are illustrated in a new bulletin, No. 905, just issued by The Buda Co., Harvey, Ill. The bulletin describes the operating principles of the Buda engine, its construction and typical installations.

A BOOKLET illustrating the many industrial applications of Micarta, a plastic material available in many grades and shapes, has recently been announced by the Westinghouse Electric & Mfg. Co. Listed are the mechanical and electrical properties, the standard forms available such as sheet, rods, tubes, angles, channels, specially molded pieces, etc. Specific applications in electrical manufacturing, radio, aircraft, automobiles, paper mills, steel mills, textile mills, chemical plants, etc., are included.

CONSTRUCTION, engineering and installation data for unit heaters are included in a new 48 page catalog No. 125 of the Ilg Electric Ventilating Co., Chicago, Ill.

AS THE LEADING CONSUMER of alloy steels, the automotive industry has done much to further the use of these new materials and to formulate specifications. Many cases are similar to those encountered in other industries and a new bulletin, U-1, published by The International Nickel Co., 67 Wall St., New York, discusses the automotive uses of nickel alloy steels from this standpoint.

CATALOG No. 8901 of the Brown Instrument Co., Philadelphia, Pa., covers the complete line of Brown air operated controllers. It explains in simple language the principle of operation and illustrates the simple construction and ease with which the control units may be interchanged.

CARBONDALE MACHINE CORP., Harrison, N. J., has just issued Bulletin 1104 explaining the absorption method of refrigeration and giving detailed information on three types of absorption machines; atmospheric, double-pipe and tubular.

MCDONNELL & MILLER, Wrigley Bldg., Chicago, announce a new 32 page booklet on float operated valves and switches including the McDonnell water level control.

CONSTRUCTION AND APPLICATION of Twin G-Fin sections heat exchangers for heating and cooling fluids of low heat conductivity are covered in Bulletin 1611 of The Griscom-Russell Co., 285 Madison Ave., New York, N. Y.

SILENT CHAIN drive data and list of shock parts are given in a handsome illustrated catalog issued by Morse Chain Co., Ithaca, N. Y.

LEEDS & NORTHRUP Co., Philadelphia, Pa., announce the opening of a New England office at 422 Chamber of Commerce Bldg., 80 Federal St., Boston, Mass.

IDEAL COMMUTATOR DRESSER Co., Sycamore, Ill., has just issued a new catalog and reference book, No. I-936, covering their products.

THE CLEVELAND CRANE & ENGINEERING Co., Wickliffe, Ohio, has issued an attractive loose-leaf catalog dealing with Cleveland Electric Traveling Cranes. It covers the subject from a descriptive and basic engineering standard rather than mechanical detail and dimensions, and is well illustrated not only with details of crane parts but with installation views in various industrial plants.

THE NICHOLSON Co., Chrysler Bldg., New York City, has issued an interesting broadside bulletin which is a photographic history of storage bin and material handling installations made by this company during the last 22 yr. The equipment illustrated includes storage bins for all granular materials, materials handling equipment, elevators, conveyors, and pneumatic systems.

ROCKWOOD MFG. Co., Indianapolis, Ind., has issued Data Books Nos. 782 and 783 describing Multiple Groove Drives and Fractional Horsepower Single Groove Drives, giving in simple manner the method for selecting a drive for any set of conditions.

UNDER THE TITLE, Lower Steam Costs with Pulverized Coal Firing, the Whiting Corp., Harvey, Ill., has issued its bulletin No. 199 describing and illustrating the construction and operating features of the Whiting table roller pulverizer.

INGERSOLL-RAND Co., 11 Broadway, New York, has just published its bulletin No. 2254 which deals with JA-30 "Jackhammer," a newly developed drill for a multitude of jobs. It is widely used in place of heavier drills for light rock drilling, such as blockholding, trimming, scaling, holes for conduits, pipes, railings, foundation bolts, maintenance and demolition work.

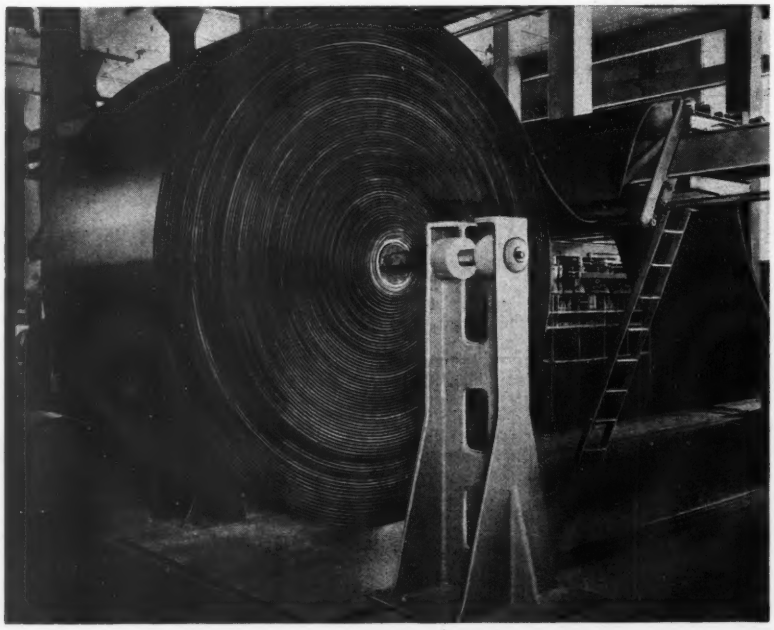
FRICK Co., Waynesboro, Pa., has recently issued its bulletin No. 198-C which is devoted to ice skating rinks in various cities throughout the country. Considerable detail is given as to the floor piping, insulation, type of floors, temperature regulation and refrigerating equipment.

MIDWEST welding fittings are described in a new bulletin, WF-36, issued by Midwest Piping & Supply Co., Inc., 1450 S. Second St., St. Louis, Mo. The bulletin not only describes the fittings and their method of manufacture but gives a large amount of data on dimensions, weights and prices.

THE DEFENDER AUTOMATIC REGULATOR Co., St. Louis, Mo., has recently issued bulletin No. 33-C-2 dealing with Junior Model single and twin type draft and wind box pressure gages and bulletin No. 33-D which illustrates and describes the Defender single and multiple unit types of draft gages used in the control of boiler operation.

THE 1936 EDITION of the Johns-Manville Industrial Products Catalog is now available. This 60-page book, profusely illustrated, contains a large amount of information and recommendations on high and low temperature insulations for industrial needs, specifications on J-M Bonded-asbestos built-up roofs, and J-M insulated roofs; detailed information on J-M corrugated Transite for roofings and sidings, on industrial friction materials, on Transite conduit, Asbestos Ebony and other J-M electrical materials, on Transite pressure pipe for industrial and municipal water lines and on J-M packings. Among new products described in detail are Transite Korduct, a thin-walled form of asbestos-cement electrical conduit; Rock Cork pipe covering, a mineral insulation for low temperature piping, and J-M Ohmstone, a non-impregnated asbestos-cement sheet for switchboard panels that will stand shock and vibration and is immune to carbonization; also Steeltex floor lath, Welded-wire reinforcement, and sound control of mechanical equipment.

COCHRANE Hot Water Softener of the Deaerating Type is described and illustrated in Publication 2059 issued by Cochrane Corporation, Philadelphia, Pa. Method of combining deaerating and softening elements to give a simple, compact and low cost arrangement is brought out, also the details of floor proportioning, phosphate feeding, sedimentation and back washing.



Largest Roll of Conveyor Belt Ever Made

This is believed to be the largest roll of conveyor belt—also the biggest single piece of Mechanical Rubber Goods—ever produced. Made in the Passaic, N. J. plant of United States Rubber, the roll, before crating, stood 10 feet 10 inches high and weighed over 15 tons. The belt, a 60 inch 10 ply U. S. Matchless, is 1,355 feet long. It is to be installed in the largest copper mining unit in Arizona as a part of equipment that will make possible the handling of 20,000 tons of ore daily.

WHERE TO BUY ACI COALS, an attractively printed folder, has just been issued by Appalachian Coals, Inc., Cincinnati, Ohio, giving a list of agents who are authorized to distribute the high-volatile coals produced by companies affiliated with the Appalachian marketing agency. ACI Coals, which are mined in Kentucky, Tennessee, Virginia, and West Virginia, are available to industries and retail coal merchants in more than 20 states, the printed folder identifying coals by seams.

THE DELTA-STAR ELECTRIC CO., Chicago, has published a new three-color 48 page bulletin No. 32-C, describing a complete line of outdoor disconnecting switches, fuse mountings and combination units in voltages up to 161 kv. Complete dimensions, insulator flashovers and cantilever strengths are given. The fuse section includes recommendations for transformer protection and charts for determining blowing time of fuses for predetermined short-circuit values. Potential transformer resistors, terminal lugs, cross arm hangers, fuse tongs, hook sticks and pipe fittings are also included. Catalog numbers, dimensions and data are arranged for easy use and reference by draftsmen. A complete price list accompanies the bulletin. Copies upon request.

"CONSOLIDATED ODOR Adsorbers in Air Conditioning" is the title of an 8-page pamphlet issued by the Consolidated Air Conditioning Corp., 114 East 52nd St., New York, N. Y. The purpose of this pamphlet is to show in a scientific manner the savings possible on air conditioning work by the use of the odor adsorbers. Copies of this pamphlet will be sent free upon request.

PROPERTIES and applications of heat treated wrought nickel alloy steels are covered in a new bulletin, P-1, published by The International Nickel Co., Inc., 67 Wall Street, New York, N. Y.

RECTOX COPPER OXIDE rectifiers for changing a.c. to d.c. without moving parts or chemical reaction are described in a new 12-page bulletin, B-2078, issued by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The booklet tells what the Rectox is, where it can be used, gives a summary of its advantages, tells how to select proper size and gives application data.

WORTHINGTON Aids for the Contractor is the title of a new, 24-page bulletin, WP-1061, issued by Worthington Pump and Machinery Corp., Harrison, New Jersey. This bulletin shows power, compressed air, drilling, pumping, and miscellaneous equipment on the job and in the shop.

HYDROSEAL pumps for sand, slime, sludge and slurry . . . made with Maximix soft rubber parts, easily replaced and designed so as to keep abrasives from touching the metal parts, are described in a new 23-page booklet in color issued by The Allen-Sherman-Hoff Co., Lewis Tower, Philadelphia, Pa.

TEMPERATURE CONTROLS of the Automatic Temperature Control Co., 34 E. Logan St., Philadelphia, Pa., are described and illustrated in Bulletin G-9 recently issued.

M. H. SKINNER Co., South Bend, Ind., has just issued a folder describing its newly designed emergency pipe clamps which are used to stop pipe leaks of steam, water, or other fluids under any temperature or pressure.

NATIONAL AIR CONDITIONING, INC., 101 Park Ave., New York City, has recently issued a 12-page folder entitled "There Is No Place Like the Air Conditioned Home." This folder discusses the functions of true air conditioning equipment and describes the construction and operation and installation of its three new basement type "Packaged Weather" units for homes and small buildings.

THE ELECTRIC CONTROLLER & MFG. CO., 2700 E. 79th St., Cleveland, O., is distributing a pamphlet entitled "Theory and Application of Resistance Welding" which was prepared by L. H. Frost, Welding Engineer of the company. The pamphlet should prove of particular value to users of resistance welding machines as it includes information in regard to the proper welding procedure and the correction of faults that may be encountered when using this method of fabrication.

YORK ICE MACHINERY CORP., York, Pa., has issued a new bulletin describing in an attractive way various types of ammonia compressors manufactured by the company ranging in size from 6 by 6 to 12 by 14 in. with V-belt, synchronous motor drive or flat belt drive. Many details of construction are illustrated.

FRIEZ Insertion humidistat mounted with Supreme solenoid water valve for use in air conditioning by insertion in the return cold air duct is described and illustrated in a leaflet, No. 3820, issued by Supreme Electric Products Corp., Rochester, N. Y. The humidistat is manufactured by Julien P. Friez & Sons, Inc., Baltimore, Md.

BEAVER PIPE TOOLS, Inc., Warren, Ohio, has recently issued a general catalog illustrating and describing the complete line of pipe threading and cutting tools manufactured by the company. Many of these are entirely new since 1929 and others have undergone substantial change in construction and design which has not only made them more accurate in their work but also more convenient for the operator.

JULIEN P. FRIEZ & SONS, INC., Baltimore, Md., has recently published an abridged catalog depicting the entire line of Friez meteorological equipment, which is presented under the title of Standard Instruments. This 16 page catalog is well illustrated and describes the company's instruments for indicating and recording such weather conditions as temperatures, humidities, air pressures, wind velocities, rainfall, sunshine, under nearly every condition in the industry.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, CIRCULATION, ETC.,

required by the Act of Congress of March 3, 1933, of Power Plant Engineering, published monthly at Chicago, Illinois, for October 1, 1936.

State of Illinois, } ss.
County of Cook, }

Before me, a Notary Public in and for the State and county aforesaid, personally appeared Arthur L. Rice, who, having been duly sworn according to law, deposes and says that he is the Editor of the Power Plant Engineering and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management (and if a daily paper, the circulation), etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

1. That the names and addresses of the publisher, editor, managing editor, and business managers are:

Publisher, Technical Publishing Co., Chicago, Ill.

Editor, Arthur L. Rice, Chicago, Ill.

Managing Editor, R. E. Turner, Chicago, Ill.

Business Manager, E. R. Shaw, Chicago, Ill.

2. That the owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the name and addresses of stockholders owning or holding one per cent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a firm, company, or other unincorporated concern, its name and address, as well as those of each individual member, must be given.)

Technical Publishing Co.
E. R. Shaw, Chicago, Ill.
Arthur L. Rice, Chicago, Ill.
K. L. Rice, Chicago, Ill.
Madge W. Rice, Wilmette, Ill.
Charles S. Clarke, Chicago, Ill.
R. E. Turner, Chicago, Ill.
A. W. Kramer, Chicago, Ill.

3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.)

There are none.

4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

5. That the average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the twelve months preceding the date shown above is ..... (This information is required from daily publications only.)

TECHNICAL PUBLISHING CO.
ARTHUR L. RICE,
Editor.

Sworn to and subscribed before me this 21st day of September, 1936.

[Seal.] JOHN O. AARVOLD,
Notary Public.

(My commission expires March 20, 1940.)

Power Plant Construction News

Calif., El Centro—Imperial Ice & Development Co., El Centro, plans early rebuilding of portion of ice-manufacturing and refrigerating plant, recently destroyed by fire. Loss reported over $40,000, with machinery. J. E. Collins is general manager.

Calif., Los Angeles—Flintkote Co., 50 West Fiftieth Street, New York, N. Y., manufacturer of roofing products, building papers, etc., plans installation of electric power equipment in new mill at Vernon, Los Angeles, where site has been selected. Cost close to $1,000,000. Pioneer-Flintkote Co., 5500 South Alameda Street, Los Angeles, a subsidiary interest, will be active in project.

Calif., South San Francisco—Wildberg Brothers Smelting & Refining Co., 742 Market Street, San Francisco, plans installation of power equipment in three one-story additions to metal smelting and refining plant at South San Francisco. Entire project will cost over $50,000. Jesse Rosenwald, 525 Market Street, San Francisco, is consulting engineer.

Del., Wilmington—Atlas Powder Co., Delaware Trust Building, plans installation of electric power equipment in new plant for production of special alcohols, comprising several large units on tract of land on Delaware River, recently purchased. Entire project will cost over $800,000. A steam power house is planned.

Fla., Dunedin—B. C. Skinner Co., manufacturer of processing machinery for controlling citrus fruit decay, plans steam-electric power plant at proposed local factory, including boiler unit and accessories, steam turbo-generator and auxiliary equipment. Electric power equipment will be installed for factory service. Entire project will cost over $80,000.

Fla., Hialeah—Miami Springs Distilling Co., recently organized, W. J. Hicks, general manager, plans installation of power equipment in new multi-unit distilling plant. A power house will be built. Entire project will cost about $100,000.

Idaho, Caldwell—Idaho Meat Producers, Inc., L. W. Botken, Caldwell, secretary, recently organized, plans installation of electric power equipment in new local meat-packing plant. Entire project will cost about $120,000. Menges-Mange, Inc., 1515 North Grand Street, St. Louis, Mo., is engineer.

Idaho, Sandpoint—City Council has plans maturing for new municipal hydroelectric power plant on site on Priest River. Cost about $150,000. Financing is being arranged. Transmission line will be built for power supply for municipality.

Ill., Chicago—Kraft-Phenix Cheese Co., 400 Rush Street, plans installation of electric power equipment in new five and nine-story and basement plant on Peshtigo Court, from Grand Avenue to Illinois Street. Bids will be asked on general contract in December. Cost close to $2,000,000. Mundie, Jensen, Bourke & Havens, 39 South LaSalle Street, are architects. James L. Kraft is president.

Iowa, Forest City—Common Council has authorized plans for new municipal electric power plant and proposes to take bids for equipment at early date. Cost about $165,000. Project has been approved at recent special election. W. C. Haugland is city clerk, in charge.

Iowa, Spencer—City Council is considering extensions and improvements in municipal electric power plant, including installation of new 2000-kw. turbo-generator unit and accessory equipment. Young & Stanley, Muscatine, Iowa, are consulting engineers.

Iowa, Waterloo—Alstadt & Langlas Baking Co., 1428 Mulberry Street, plans installation of power equipment in new one-story addition to baking plant, 130x140 ft., including traveling ovens, etc. Entire project will cost close to $45,000.

Ky., Covington—Board of Education, City Hall, has plans maturing for new steam power house at high school on Madison Avenue, for central heating service, with installation of boiler units and accessories, stokers, pump and other equipment. Financing has been arranged through Federal aid. C. C. and S. K. Weber, St. Paul Building, Cincinnati, Ohio, are architects.

Ky., Louisville—Louisville Gas & Electric Co., Louisville, plans new steam-operated electric power plant, with steam turbo-generator units and auxiliary equipment for initial capacity of 25,000 kw. Cost estimated close to $1,800,000. Application for permission has been made.

Md., Baltimore—Owens-Illinois Can Co., Boston Street, plans installation of electric power equipment in new three-story addition, 180x260 ft., to local metal container plant. Permit has been issued and work will begin soon. Cost close to $300,000. Company is a subsidiary of Owens-Illinois Glass Co., Toledo, Ohio. Francisco & Jacobus, 511 Fifth Avenue, New York, are architects and engineers.

Mass., Malden—Continental Can Co., 100 East Forty-second Street, New York, N. Y., plans installation of electric power equipment in new three-story branch plant, 140x160 ft., on Eastern Avenue, Malden. Cost about $100,000. Superstructure will proceed at early date.

Miss., Clarksdale—Coca Cola Co., Atlanta, Ga., plans installation of electric power equipment in new branch beverage plant at 820 Fourth Street, Clarksdale. A steam power house will be built. Cost over $65,000.

Mo., St. Louis—St. Louis Independent Packing Co., 3815 Chouteau Street, plans installation of power equipment in connection with expansion and modernization of meat-packing plant. Cost over $400,000. Work is scheduled to begin soon.

N. J., East Rutherford — Flintkote Co., 50 West Fiftieth Street, New York, plans installation of electric power equipment in new addition to roofing products and asbestos goods plant at East Rutherford. Cost close to $750,000.

N. J., Newark—Hoffman Beverage Co., 402 Grove Street, plans installation of power equipment, mechanical-handling, loading and other equipment in two new additions, seven and four-story, respectively, for expansion in aging, storage and distributing departments. Cost about $175,000. Epple & Kahrs, 17 Washington Street, are architects and engineers.

N. Y., Brooklyn—Brooklyn-Manhattan Transit Corporation, 385 Flatbush Avenue Extension, plans extensions and improvements in steam-electric generating plant in Williamsburg district, including complete modernization. New equipment will be installed for large increase in present capacity. Cost about $4,000,000. Application has been made for permission.

N. C., Wilmington—Atlantic Refining Co., 260 South Broad Street, Philadelphia, Pa., plans installation of pumping machinery and accessories, steel tanks and other mechanical equipment in new bulk oil terminal on Cape Fear River, near Wilmington. Entire project will cost close to $850,000.

Ohio, Cleveland—Fisher Body Corporation, Coit Road and East 140th Street, a unit of General Motors Corporation, General Motors Building, Detroit, Mich., plans installation of electric power equipment in new one-story addition, 200x400 ft. Cost over $175,000.

Ohio, Norwalk—City Council is considering extensions and improvements in municipal electric power plant, including installaton of new 2500 kw. generator unit and auxiliary equipment.

Ohio, Painesville—Industrial Rayon Corporation, West Ninety-eighth Street and Walford Avenue, Cleveland, Ohio, plans installation of electric power equipment in new mill near Painesville, where tract of 400 acres of land has been acquired. New plant will total over 300,000 sq. ft. of floor space; a steam-electric power plant and water purification station will be built. Entire project will cost over $5,000,000. Wilbur Watson & Associates, 4614 Prospect Avenue, Cleveland, are architects and engineers.

Tenn., Gallatin—General Shoe Corporation, 511 Gallatin Avenue, Nashville, Tenn., plans installation of electric power equipment in new branch factory at Gallatin where arrangements have been made with municipality for project. Cost about $80,000. Work will begin soon.

Texas, Bay City—City Council has plans under way for new municipal electric power plant, using Diesel engine-generator units and auxiliary equipment, comprising three 600 hp. engines direct-connected to three generators. Local distributing system of Central Power & Light Co., will be acquired and improved. Entire project will cost about $225,000. Garrett Engineering Co., 308 Hughes Street, Houston, Tex., is consulting engineer.

Wash., Seattle—Department of City Lighting, City Light Building, J. D. Ross, superintendent, plans new power substation to cost about $845,000, with equipment, in connection with development of hydroelectric power plant on Skagit River, including raising of power dam and other work. A steel tower transmission line will be built from power station to city limits, to cost $1,500,000. Financing has been arranged through Federal aid and municipal financing in gross amount of $3,667,000 for entire project.

Wis., Fort Atkinson—City Council is considering construction of a municipal electric power plant. Estimates of cost are being made. It is proposed to purchase existing distributing system of Wisconsin Gas & Electric Co., and make extensions and improvements. G. L. Van Fleet Co., Dubuque, Iowa, are consulting engineers.